Low Carbon Energy Transitions for Informal Settlements: A Case Study of iShack South Africa.

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Declaration

I, Zachariah Glasser, hereby declare that the work on which this dissertation/thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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Acknowledgments

Thank you, Father, for putting this dissertation on my heart and challenging me throughout this entire process. I am so grateful for your reminder that "the needy shall not always be forgotten, and the hope of the poor shall not perish forever" – Psalm 9:18. You are an incredible God.

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I dedicate this project to the children of Enkanini. Their ability to find happiness and always have a smile, despite their surroundings, is an incredible mystery.

Ethical clearance

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20 June 2016

Mr Zachariah Glasser
African Climate and Development Initiative

Low carbon energy solutions in incremental housing projects in South African townships

Dear Mr Zachariah Glasser

I am pleased to inform you that the Faculty of Science Research Ethics Committee has approved the above-named application for research ethics clearance, subject to the conditions listed below. You are required to:

- Implement the measures described in your application to ensure that the process of your research is ethically sound; and
- Uphold ethical principles throughout all stages of the research, responding appropriately to unanticipated issues: please contact me if you need advice on ethical issues that arise.

Your approval code is: **FSREC 026** – 2016

I wish you success in your research.

Yours sincerely

Prof Timm Hoffman
Chair: Faculty of Science Research Ethics Committee

Cc Supervisor: Dr Zarina Patel

Abstract

The majority of informal settlements in South Africa do not have access to reliable, safe, and clean energy. Infrastructural constraints, poor service delivery, the inapt application of policy, and the financial constraints of those living in informal settlements all contribute towards this problem of energy poverty.

This dissertation argues that low carbon energy transitions, such as solar home systems, are a viable means for overcoming issues of energy poverty in informal settlements. This dissertation examines the role of urban experimentation in implementing low carbon energy transitions within informal settlements in South Africa, through exploring interactions between policy, technology and justice.

The iShack Project (*improved* Shack) is used as a case study, to identify, analyse, and discuss the ways in which solar home systems have resulted in social and financial changes amongst the residents in Enkanini, Stellenbosch. These relate to changing fuel use patterns, reducing shack fire risk and addressing issues of access and affordability.

Multilevel perspective (MLP) and the political ecology approach are the two analytical tools used to discuss the broader conditions that give rise to transitions, as well as providing a more in-depth look at the experiences of those making up the 'social' aspect of socio-technical transitions. These analytical tools informed a series of interviews, which is the primary method through which data was gathered, by highlighting prominent components of agency and power – providing greater understanding of the lived realities of

the Enkanini residents. The interviewing process provided an opportunity for residents of Enkanini to voice their opinions on this urban experiment and discuss the impact iShack has had on their lives. Photographs accompany many of the findings in this dissertation and provide a valuable lens through which the lived reality of the Enkanini residents can be more accurately represented.

Using the case study of the iShack Project in Enkanini, the findings of this dissertation highlight that policy, technology and justice come to positively reinforce one another in addressing the issue of energy poverty in South Africa. For example, the granting of the Free Basic Electricity (FBE) subsidy to the iShack Project has made it possible for the intermediary to address justice issues, such as the poor being able to access and afford reliable, safe, and clean electricity.

Furthermore, iShack's technological innovations, such as "Flash" and the "Flash wallet" have brought about foundational changes in some values, goals, operational procedures and decision-making processes taking place in the community – especially around the notion of monetary savings. This also points to the fact that these technological innovations are physical manifestations of policy itself.

The findings show that low carbon energy transitions can be a viable means of overcoming energy poverty in informal settlements and addressing issues of access and affordability for the poor. However, local government plays an important role in being able to adapt local policy in such a way that it creates an enabling environment for an intermediary to be supported or strengthened in this.

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List of Acronyms

FBE	Free Basic Electricity
FBAE	Free Basic Alternative Energy
FB-PAYG	'Free Basic' pay-as-you-go
iShack	Improved Shack
MLP	Multi-level perspective

List of Definitions

Contract clients: Clients who pay R130 a month for the services rendered to them by iShack.

Deurmekaar: a state of confusion.[1]

'Free Basic' pay-as-you-go clients: Clients who do not pay any monthly service fees to iShack.

Niche market: a part of the market that a specific product is focused.

Repossessed: when a system, or an appliance of the system (such as a TV), is taken away from a client due to that contract client defaulting on their payments or a client leaving Enkanini. As well as the system being placed at risk of: water damage, lack of security, tampering or repeat fines.

Shebeen: an informal licensed drinking place in a township.[2]

Skolly: a petty criminal/hooligan.[3]

Umlungu: a somewhat offensive form of address for a white person.[4]

[1] Deurmekaar. (2017). In Oxforddictionaries.com. Retrieved from https://en.oxforddictionaries.com/definition/deurmekaar
[2] Shebeen. (2017). In Oxforddictionaries.com. Retrieved from https://en.oxforddictionaries.com/definition/shebeen
[3] Skolly. (2017). In Oxforddictionaries.com. Retrieved from https://en.oxforddictionaries.com/definition/skolly
[4] Umlungu. (2017). In Oxforddictionaries.com. Retrieved from https://en.oxforddictionaries.com/definition/umlungu

1. Introduction

Energy poverty affects the majority of informal settlements in South Africa, who do not have access to reliable, safe, and clean energy (Swilling, et al. 2013). Energy poverty is defined by Bouzarovski, et al. (2011) as a household's inability to access socially or materially required levels of energy services. Patterson (2013) highlights a disjuncture in the government-led roll out of energy who, through Eskom[5], has made considerable progress in electrifying an average of 300 000 homes a year. However, this has not impacted the lives of those who still do not have access to formal housing. As a result, the appropriateness of Eskom's electrification strategy and the extent to which it addresses questions of energy security in informal settlements can be questioned.

Environmental justice underpins questioning the importance and efficiency of subsidised service delivery for the poor, as simply connecting homes to the national grid does not automatically increase the ability of the poor to access and afford electricity. This essentially impedes their right to a healthy living environment (Walker and Day, 2012). Many newly connected households and residents living in informal settlements cannot afford to pay for the amount of electricity they use/desire, or to cover the costs of electrification (Patterson, 2013). The Free Basic Electricity (FBE) policy was implemented for this very reason; to support an overwhelming number of poor households meet their basic energy needs, by allocating 50kWh per month to all poor households connected to the national grid (DME, 2007).

[5] South Africa's electricity public utility

However, what of the residents in informal settlements who are not connected to the national grid? These informal settlements are essentially blind spots in this 'pro-poor' policy. However, low carbon energy transitions aim to specifically address the political, financial and physical barriers associated with energy poverty, and issues of access and affordability in these settlements.

Ultimately, the electrification of informal settlements continues to face various challenges: the appropriate application of policy, such as the FBE and Free Basic Alternative Energy (FBAE) policies, in supporting electrification; the financial constraints of those living in informal settlements to attain energy security, as well as the physical complexities associated with the continuous expansion of these settlements (Davis, 1998; Winkler, 2005; Bekker, et al., 2008). Tomlinson (2015) highlights that informal settlements have grown nationally from around 300 to over 2200 from 1993 to 2015, due to population growth and urbanization, and are only expected to increase.

However, as Satterthwaite (2009: 557) argues, even "if most of the growth in the global population is among low-income households in low-income nations, there is and will be little connection between population growth and GHG (greenhouse gas) emissions growth," bearing very little impact on climate change. This is due to the fact that these households rarely make it out of the poverty cycle and do not have access to consumption levels that cause significant levels of GHG emissions per person.

Technological innovation has an important role to play in the development and introduction of low carbon energy transitions in these informal settlements, and more broadly, urban transitions in general. As Smith, Voß

and Grin (2010: 2) argue, technological innovation results in the development of "new products, processes and services that improve human wellbeing." Furthermore, Nevens, et al. (2013) highlight the broad transformational potential of technological innovation, arguing that technological innovation is also crucial in stimulating socio-political, infrastructural and environmental transitions. The introduction of low carbon energy transitions into informal settlements, in many ways, aims to address the shortfalls of service delivery and improve both its efficiency and delivery, to the benefit of those living in informal settlements.

This dissertation argues that low carbon energy transitions, such as solar home systems, are a viable means for overcoming issues of energy poverty in informal settlements. The iShack Project in Enkanini is used as a case study. The study seeks to investigate the relationship between technological innovations and how the associated benefits of low carbon energy transitions in Enkanini help address issues of accessing and affording electricity, as well as contributing to positive changes in social norms – such as less frequent shack fires and the promotion of saving schemes.

As described by Rotmans, et al. (2001), transitions are a set of connected changes that reinforce each other. More specifically, Foxon, et al. (2005: 2258) describes low carbon transitions as changes that take place in the practices of energy use, innovations and the implementation of low carbon technologies, with broader changes occurring with regards to the energy mix of industries and within the national and global economies. Kuzemko (2013) argues that low carbon transitions are long-term processes that involve various fields (such as the economy, technology, politics, ecology, etc.) and that governance is central to these transitions and in supporting niche

markets. This once again reinforces the notion that the electrical supply system is shaped by a variety of influences, and it also highlights the possibility for conceptualising low carbon energy transitions and development differently.

As a socio-technical system, Geels and Schot (2007) argue that electrical supply systems must be viewed holistically, and when doing so it becomes clear that it is a system influenced by a number of economic, political and social factors. However, at the core of this socio-technical regime is the policy that directs it. The European Commission (2016) echoes this sentiment by arguing that policy is a mechanism that should be used to create an enabling environment, one which would help social enterprises scale their impact in providing the technological innovations and services needed in these communities. This largely takes place by recognizing the "social added value" of social enterprises – by examining whether or not their services or products have an impact on the problem they aim to solve and if their operations can be upscaled to include more people (European Commission, 2016: 3).

Clearly there is a link between policy and technological innovation, as well as policy and justice, within the realm of energy poverty. This highlights the importance of analysing the relationship between the FBE and FBAE policies and the creation of just cities (Harvey, 2003; Marcuse, et al., 2009; Fainstein, 2010). As well as understanding how this might influence social enterprises, such as the iShack Project, which seek to implement low carbon energy transitions in informal settlements.

From the case study of the iShack Project in Enkanini, this dissertation will analyse and learn how low carbon energy transitions are initiated and implemented in informal settlements, and the possibility of upscaling. This is important, as informal settlements and niche innovations typically operate outside the realm of government policy. As a result, this dissertation will focus on the role and impacts the FBE and FBAE policies have had on the implementation of low carbon transitions in Enkanini. This is an important aspect of identifying the opportunities and/or constraints policy may afford low carbon energy transitions in informal settlements.

It is within this context that this dissertation will focus on the iShack Project as a case study. It is an example of an urban experiment that has introduced a low carbon energy transition (solar panels) into an informal settlement. The Project acts as an intermediary between the state, private sector and the Enkanini community in Stellenbosch. It provides the infrastructure (solar panels and batteries), maintenance and delivers appliances (low voltage TVs, lights, cell-phone charging capabilities and in the future, fridges and water heaters) from their headquarters in Stellenbosch to Enkanini, which incrementally improve the living standards of the residents; those who are not connected to the national grid.

As Bulkeley and Castán Broto (2013) argue, urban experimentation allows for the testing and establishment of new practices, that often accompany development, which end up supporting or contesting knowledge claims and regimes. An urban experimentation lens is therefore useful for this dissertation, as it holds potential in creating windows of opportunity to conceptualise low carbon energy transitions and development differently, which challenge contemporary socio-technical regimes. It allows for an

argument to be made, that solar utility providers, such as the iShack Project, can be a viable means by which energy poverty and inefficient service delivery can be addressed in informal settlements.

The iShack Project carries out such experimental action by providing solar home systems to clients, some of which are pay-for-use, which use solar electricity as a means of achieving affordable, renewable, scalable and sustainable energy production for the poor ("iShack Project", n.d.). The iShack Project aims to address issues of access and affordability by providing a service that is easily accessible and affordable to the poor, as well as achieving broader equity within informal settlements through efficient service delivery. The focus on this urban experiment is to identify, analyse and discuss the influence this low carbon energy transition has had on the residents in Enkanini. Specifically, the impact it has had on their finances, their daily practices and their access to and the availability of energy.

MLP and the political ecology approach are two analytical tools that will be used to discuss the broader conditions that have given rise to this low carbon transition in Enkanini, as well as providing a more in-depth look at the experiences of those making up the 'social' aspect of socio-technical transitions. The MLP framework helps achieve this by providing "narrative explanations" that form as a result of these interactions (Geels and Schot, 2007). This can help identify the opportunities needed for the future arrangement of socio-technical regimes, often occurring through urban experimentation (Hodson and Marvin, 2010).

1.1. Aim

To investigate the factors influencing the introduction and effects of low carbon energy transitions in informal settlements in South Africa.

1.2. Objectives

There are three objectives for this dissertation. The first is to analyse and learn how low carbon energy transitions are initiated and implemented in informal settlements, for possible upscaling. In this way, this dissertation can provide insights and evidence for low carbon energy solutions in informal settlements. Literature on urban transitions theory and intermediaries informs the way in which landscape and regime shifts can take place, by identifying windows of opportunity for urban experimentation. This is significant in that identifying the right windows of opportunity can lead to regime changes through urban experimentation; from which intermediaries are able to "re-think" contexts through technological transitions, which in turn opens up new points of intervention (Hodson and Marvin, 2009).

Secondly, the role of intermediaries in the process of experimentation will be analysed and discussed, focusing specifically on how windows of opportunity are utilized for the introduction of new innovations, as well as the improvement of services and technology, in informal settlements. The iShack Project is an example of an urban experiment that mediates the relations between technological potentials and the local context. As a case study, it will be used to highlight the relationship between community engagement and its influence on innovation, both technological and for policy. The introduction of new battery units, called "BBOXX units", will be the focus. More specifically, on their introduction as a new innovation aimed at

improving both the service and technology used by the residents in Enkanini. The study will detail the social benefits and changes of this intervention.

The third objective is to analyse the relationship between justice and technology, by unpacking the multiple dimensions of justice in the roll out of the FBE/FBAE policies in informal settlements. In doing so, the rationale, objectives and impacts of the FBE and FBAE policies on the iShack Project and the Enkanini residents will be analysed.

Cumulatively, addressing these objectives is central to investigating the factors influencing the implementation of low carbon energy transitions in informal settlements in South Africa, as well as identifying changes that could assist and promote this transition.

1.3. Research Questions

This dissertation has a set of research questions, that aim to understand the feasibility of low carbon transitions in informal settlements. Specifically, this aim was investigated through the following three research questions:

1. What is the gap between policy and the delivery of energy solutions to informal settlements?

2. What is the role of intermediaries and urban experimentation in the development and delivery of niche innovations to informal settlements?

3. What is the relationship between FBE/FBAE and the creation of just cities?

2. Literature review

This literature review focuses on urban transitions theory and discusses the way in which it provides a lens for understanding and analysing opportunities to change landscapes and regimes. Through this lens, regime changes can be achieved under the following conditions: if the right windows of opportunities are identified; and through urban experiments. Urban experiments are one of the ways in which niche innovations can be developed and implemented, resulting in regime change. As mentioned earlier, within the context of this study, it would allow for low carbon energy transitions and development to be conceptualised differently. Allowing for an argument to be made, that solar utility providers, such as the iShack Project, can be a viable means by which energy poverty and inefficient service delivery can be addressed in informal settlements.

The MLP and political ecology approach will be discussed in detail, so as to outline their analytical potential and their scope within the context of this dissertation. These two analytical tools will be used when analysing theories of environmental justice, urban experimentation and intermediaries, and the ways in which they influence and are influenced by transitions. Both the South African context and the case study of the iShack Project will be used to help better understand the ways in which aspects of environmental justice, urban experimentation and intermediaries come to manifest themselves and operate within the realms of an informal settlement, such as Enkanini.

2.1. Urban Transitions

Hodson and Marvin (2010) suggest that urban transitions take place when issues or constraints (economic, ecological, or institutional factors) produce new challenges and pressures on urban growth and the management of a cities' critical infrastructure. It is the urban response to these pressures that is the main focus of urban transitions theory, often resulting in urban experimentation and new opportunities for the future arrangement of the social and technical organizations within cities (Hodson and Marvin, 2010).

Urban transition theory and the process of encouraging and implementing niche innovations involve many voices, views and stakeholders. Focusing on one group of stakeholders would be far too subjective in attempting to understand the process as a whole.

2.1.1. Types of transitions

Smith, et al. (2005) considers four different types of transitions that can take place, as well as their defining characteristics and context. The first is, 'endogenous renewal' which is carried out by members of a regime through highly coordinated responses that are supported by the resources within that regime (Smith et al., 2005). As a result, these responses come to reflect the interests, ideologies and values of that regime, and the change that takes place tends to be incremental (Smith et al., 2005).

The second type of transition is the 're-orientation of trajectories'. This occurs in regimes that encounter some sort of radical re-orientation, normally termed a 'shock' or 'shift', which can take place from either inside or outside the regime itself (Smith, et al., 2005). It is important to identify the way in which actors of a regime define these 'shocks', as it will often shape the way

in which a regime responds to it and its future trajectory. Furthermore, the way in which a 'shock' is defined can highlight a range of various alternative measures that could be implemented and the various associated outcomes.

At an institutional/infrastructural level, one example would be that of an energy crisis, and the transitions that would have to take place to secure safe, reliable energy. The means of securing energy and the type of energy produced (fossil, renewable, nuclear, etc.) would also reflect the interests, ideologies and values of that regime, as well as the political elite that control it.

'Emergent transformations' are the third kind of transition. They often occur due to uncoordinated external pressures and normally take the form of technological innovation that emerges from universities (Smith et al., 2005). Lastly there are 'purposive' transitions, which are more active than reactive as there is a strong degree of intention in pursuing this regime transition and coordinating actors and resources from outside the regime itself (Smith et al., 2005).

2.1.2. Urban Transitions Framework and the MLP

Regardless of the type of transition, all transitions interact at three 'levels. A strength of the urban transitions framework is its focus on the interactions of these three 'levels'. These 'levels' are not scalar and the urban transitions framework does not aim to establish a hierarchy. Instead, it tries to clarify that all of these levels operate with one another, and that they make up a variety of interactions that support a structural operation. Essentially, intangible entities (such as institutions or investments) can be established and directed in such a way as to support a regime, such as centralised electricity.

As Hodson and Marvin (2010) highlight, the urban transitions framework posit that transitions come about through the interactions that take place between these three levels. MLP is used as an analytical tool, to better explore and understand the 'systems innovation' that takes place when these transitions occur (Geels, 2002).

Markard and Truffer (2008: 596) focus more on the technical aspects of these interactions and describe the MLP framework as a concept "for the study of far-reaching technological change". The authors argue that it is the technological transitions that occur at the three levels that result in "interactive processes of change" (Markard and Truffer, 2008: 597). Kumetat (2014) explains that the MLP focuses on the distribution of power in societies by "an analytical division of societal processes in separate layers and actor groups." As a result, MLP provides "narrative explanations" of the 'patterns' that form as a result of these interactions (Geels and Schot, 2007). However, the primary area of analysis for MLP is that of socio-technical regimes (Kumetat, 2014).

Figure 1 below provides an in-depth analysis of the narratives, patterns and power relations that form as a result of the interactions that occur between these three levels, as well as how these influence transitions themselves.

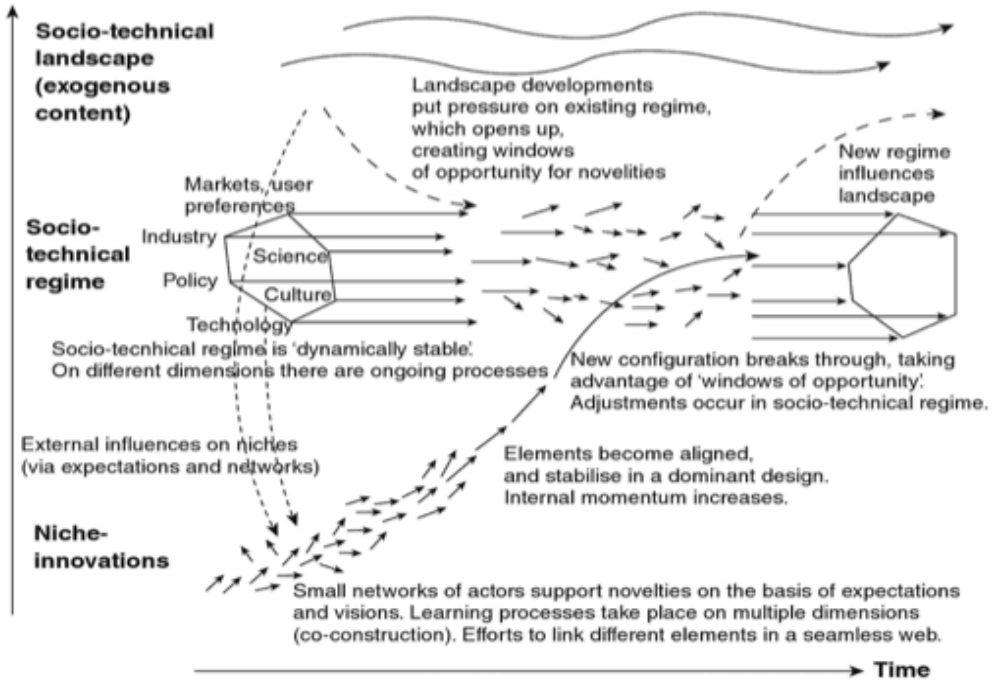

Figure 1 – A multi-level perspective on transitions (Geels and Schot, 2007).

The first of these levels is the concept of the landscape, which focuses on macro-scale trends such as political cultures or economic growth, which are regarded as 'external pressures', that affect existing socio-technical regimes and niches and result in new opportunities in which to respond (Hodson and Marvin, 2010).

Secondly, there are regimes. Regimes operate at the meso-scale and are regarded as socio-technical because they are sites in which technologies and technological functions co-evolve alongside social functions and social interests (Hodson and Marvin 2010). Here, there are a variety of voices, interests and actors that come to shape the technological development that takes place within a socio-technical regime - such as engineers, policymakers, business interests, NGOs, consumers, etc. (Hodson and Marvin, 2010). It is also at this level that MLP is primarily concerned.

Finally, niches operate at a micro-scale and are considered 'protected' spaces due to the small network of actors involved in learning, developing and implementing new technologies (Hodson and Marvin, 2010). Essentially, these can be considered vested interest groups.

Figure 2 below illustrates the three layers of the urban transitions framework and how the interactions between these three layers can ultimately lead to a transformation at the landscape level.

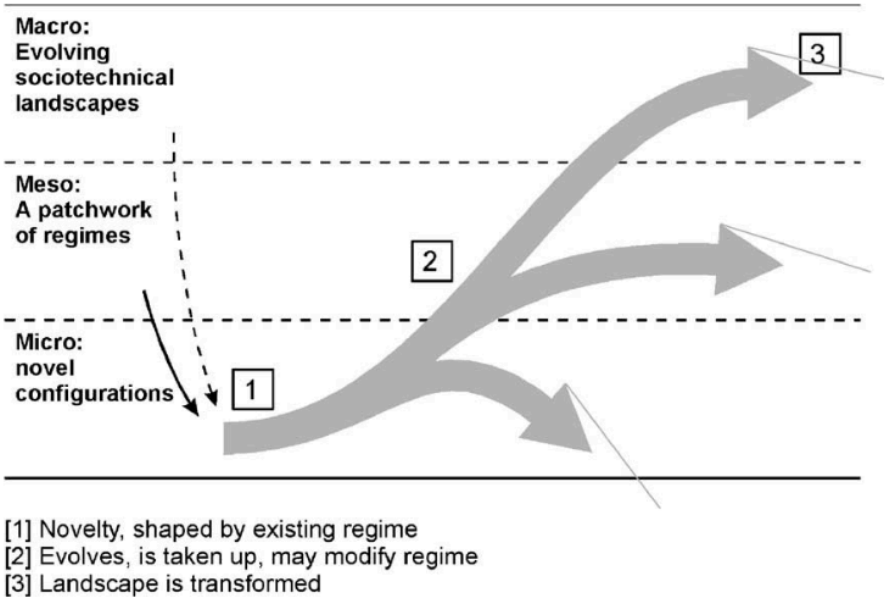

Figure 2 – The dynamics of socio-technical change (Kemp, et al., 2001).

Three critiques of the way in which proponents of the MLP conceptualize transitions will be highlighted. The first is concerned with its relative neglect of agency. Essentially, it is argued that MLP can neglect important differences in context. As Hodson and Marvin (2010) highlight, it is often the case that pressures experienced by cities are experienced differently between and within them.

Secondly, it is also argued that the conceptualization of transitions places too much emphasis on technological niches. This could devalue the social aspect of transitions and the important role that communities and agency have in shaping them. Within the context of this dissertation, technological niches should be considered a product designed for a particular/small section of the market – such a solar home systems for townships. Or in the case of the iShack Project, a company that specialises in such technologies.

Finally, both Lawhon and Murphy (2011) and Geels and Schot (2007) highlight a bias prevalent in the urban transition theory, in which it often favours 'innovation' over social factors, such as justice. Geels and Schot (2007) believe that different multi-level interactions are necessary to refine MLP and counter this bias. One aspect of this is to understand that urban transitions differ between the global north and global south, and more work needs to be done on testing it within the southern context.

2.1.3. The Political Ecology Approach

The political ecology approach adds greater focus and insight to enhance urban transitions theory, by addressing the three critiques of the MLP listed above - its relative neglect of agency, the emphasis it places on technological niches and how it often favours 'innovation' over social factors. The political ecology approach provides a platform from which both technological and social aspects of transitions can be analysed and addressed equally and in relation to one another.

As Figure 3 highlights below, there is a clear advantage and benefit in using the MLP and political ecology approach in relation to one another, especially in highlighting the social factors of "meanings", "materials" and "social practices" that come to shape a socio-technical regime.

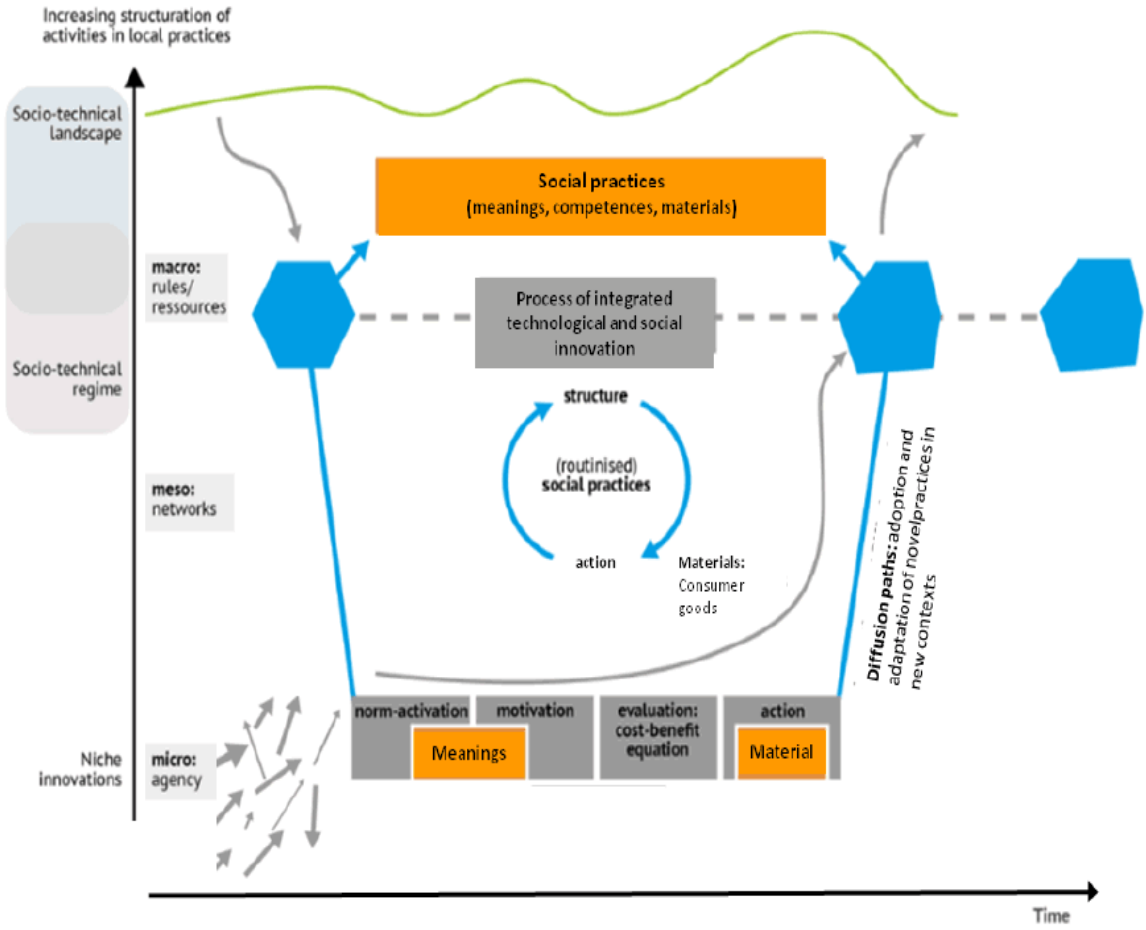

Figure 3 – A diagram highlighting components of MLP and the Political Ecology Approach (Baedeker, Liedtke, Kühlert, 2017).

This challenges the bias MLP places on innovation over social factors, in highlighting important justice issues, such as access and affordability, and how this has a direct impact on the success of transitions in the global south. Furthermore, by addressing the differences in power relations, the political ecology approach emphasizes the important role of agency – an important reflection when considering transitions within an informal settlement. This helps identify different forms of local knowledge, which come to shape transitions themselves. By addressing these critiques, the political ecology approach will help to better understand the transitions of energy services taking place in the case study, the informal settlement of Enkanini.

At its core, the political ecology approach is a broad-based analysis tool that focuses primarily on socio-political systems at various scales (Lawon and Murphy, 2011). A large portion of its enquiry is aimed at human-environmental change, and the social processes and power relations that influence and are influenced by this change (Lawhon and Murphy, 2011).

The political ecology approach supports the critical examination of claims, their validity, and investigates the necessity and/or alternatives to a transition (Lawhon and Murphy, 2011). Attention is directed towards identifying stakeholders, as well as where these stakeholders are positioned within or in relation to the socio-technical regime (Lawhon and Murphy, 2011). This is important in identifying the arguments, values and interests of the stakeholders, which may differ depending on who you are in conversation with. This allows researchers to focus specifically on a particular context and compliments what Hodson and Marvin (2010) stated, that pressures are experienced differently across and within cities.

By focusing on the socio-political components of a particular context, important differences in adaptive capacity, power and resources are often identified within and between cities. As highlighted by Geels and Schot (2007), this helps in analysing the role of agency and therefore considers one of the primary critiques of MLP.

Furthermore, it examines why stakeholders are making particular claims and whether there are in fact any counter narratives (Lawhon and Murphy, 2011). For example, is the real cause of energy poverty inefficient energy production methods or is it actually the result of an inefficient distribution system and infrastructure? More so, how do access and the affordability of energy for those living in informal settlements influence energy poverty? This

provides greater conceptual clarity than the MLP, and helps identify the real issues, arguments, values and interests of stakeholders.

The political ecology approach provides a platform that not only considers technological intervention but also looks at socially created problems (Lawhon and Murphy, 2011). Where MLP seems to fall short by focusing too heavily on technological niches, the political ecology approach creates a space to consider the social.

In summary, it is evident that the political ecology approach highlights a broader range of social and technical alternatives to consider. It does this by the way in which it considers various aspects of local knowledge, extending the scope to include multiple voices and alternative solutions to the problem. This encourages the coproduction of knowledge and links in with Luke's (2003) statement that through the development of networks and relationships, new systems of knowledge and intelligence can be created.

2.2. Environmental justice

The way in which the political ecology approach identifies and emphasizes the social processes and power relations that influence transitions, creates a platform for understanding the role of environmental justice within urban transition theory.

As Schlosberg (2009) describes, environmental justice is a social movement, which aims to ensure the fair distribution of both environmental benefits and its burdens, while achieving broader equity among all social groups. Within South Africa's contemporary socio-political and socio-economic environment, it seeks to rectify the inequalities experienced amongst the marginalised poor from the Apartheid era.

This dissertation will focus specifically on the mechanisms and processes of environmental justice that renew the focus of the state and the environment as key actors in providing and improving service delivery for the poor (Sze and London, 2008). As a result, aspects of environmental justice, such as access and affordability, are major components when considering the context of low carbon energy transitions within informal settlements.

Bullard and Lewis (1996; 15) argue that the inequality between urban areas and rural areas has been "created, tolerated, and institutionalised" by government actors. As a result, they argue that in many instances government systems is actually the problem (Bullard and Lewis, 1996). This highlights the central role government [needs to] play(s) in determining whether welfare enhancing policy recommendations, such as the FBE and FBAE, are adopted or not, in exacting environmental justice across social groups.

Environmental justice does this by providing a framework that encourages transdisciplinary conversations, which brings different actors and stakeholders around the same table (Sze and London, 2008). As Sze and London (2008: 1347) state, a major advantage of using environmental justice as a concept is the way in which it incorporates and heavily relies on the practice of theorizing "the lived realities of actual people, places, and problems."

Community engagement and public participation is therefore key to better understanding components of environmental justice and the realities and restrictions of people living in informal settlements. For an intermediary such as iShack, community engagement and public participation is at the core of ensuring 'efficiency' and long term, successful 'adoptability'. It is through

engagement and participation that the services offered by the iShack Project has evolved into something valued by residents within the community.

For this dissertation, community engagement and public participation are central in considering how changes in norms, values or goals of both the iShack Project and Enkanini residents have taken place; as well as reflecting on questions of access and affordability. These insights inform the ethnographic component of this dissertation.

Bullard and Lewis (1996) argue that environmental regulations, laws and policies are not equally applied or experienced across society, as certain individuals and communities experience less protection based on their location, race, and economic status. Walker and Day (2012) reinforce this notion by looking at energy poverty as a direct manifestation of social inequality. The authors argue that it falls under the umbrella of environmental injustice as an expression of distributive injustice - it compromises the ability of the poor to access energy services and therefore impedes their right to a healthy living environment (Walker and Day, 2012).

As Jaglin (2008) highlights, this is a gap into which the private sector and social enterprises have stepped, in an attempt to work with the state in bringing about environmental justice in rural communities through efficient service delivery. While the ultimate goal of environmental justice is to make environmental protection more democratic, Bullard and Lewis (1996) emphasize how it also considers prominent ethical and political questions, specifically concerning issues of responsibility and delivery. Such as "who should pay for this, and who is to benefit from these technological innovations?" This once again reiterates the importance of public

participation, community engagement and stakeholder consultation.

Davis (1998) emphasises the importance of considering issues of access and affordability within the energy sector for the poor. From data collected by a nationwide household survey in which some 8500 South African households were surveyed, with approximately 50% being classified as rural, he concludes that income largely drives energy transitions within rural households (Davis, 1998). Furthermore, he argues that it's mainly the issue of 'access' that determines the nature of transitions (Davis, 1998).

This is better explained by the way in which he suggests that electrified households tend to fall within the higher-income bracket, and are therefore able to access grid electricity (Davis, 1998). Essentially, it would be the inability of the poor to access grid electricity that results in the introduction of a new niche innovation, and largely determines the nature of a transition, to one that might instead rely on solar home systems. This highlights the way in which the 'access' impacts transitions, which has a clear influence on energy poverty. Furthermore, Davis (1998) argues that access to electricity actually accelerates the transition process, which may be influenced by a bias towards the higher-income communities/households. He concludes that income is a fundamental issue to access (Davis, 1998: 214-215).

Finally, work done by Bouzarovski and Petrova (2015: 32) highlight how the inability to access "modern fuels" essentially forces households into situations in which their health and safety are put at risk. Furthermore, access and affordability to safe, reliable and clean electricity has a direct impact on the livelihoods of residents, their time, income, productivity and agency, as it

also limits their access to resources and decision-making (Bouzarovski and Petrova, 2015).

The authors also highlight how the "access-affordability binary" is being challenged specifically in relation to environmental justice, focusing on state-led policies to ensure equity and to promote pathways to increase access to modern fuels that will improve livelihoods and human development (Bouzarovski and Petrova, 2015). This reinforces the need to better understand the relationship between policies, such as FBE and FBAE, and justice.

2.3. Urban experimentation

Low carbon energy transitions can take place as a result of urban experimentation. Hall (2002) reiterates this point, by introducing the notion that cities can be an urban 'testing ground' for new forms of urbanism, which may offer alternative ways of development. Parallels can be made here to Simone's (2006) view of African urbanism, as the remaking of the urban landscape, and the way in which providing alternatives for society can lead to alternative ways of learning, which result in social changes as highlighted by Patel, et al. (n.d.).

Bulkeley and Castán Broto (2013: 363) describe urban experimentation as purposive interventions that attempt to "innovate, learn or gain experience." As described by Swilling, et al. (2013), and within the context of this dissertation, urban experimentation refers to experimental action that leads to new alternative ways that give rise to efficient service delivery and development. Evans, Karvonen, & Raven (2016: 150) explain that experiments can take the form of pioneering projects and research

collaborations which result in "urban change that is visible in urban discussion and policy-making."

Urban experimentation has had significant influence in establishing pilot projects that introduce new niche innovations in different contexts (Patel, et al., n.d.). The ability to be both specific in addressing a particular problem, yet adaptable to different situations, provides a platform from which community engagement, local knowledge and change can manifest – creating opportunities for new niche innovations to arise (Castán Broto and Bulkeley, 2013a).

However, this ability to be both specific and adaptable largely rests on technological innovation and diversifying the supply chain. Being adaptable to new challenges, pressures or restraints encourage innovation. It also highlights the importance of not being dependant on one particular technology. Narasimhan and Kim (2002) highlight the importance of diversifying supply chains, emphasizing how market leaders understand the important role of differentiation in re-inventing an organization to keep it agile. More so, the authors argue that strategies need to be put in place to ensure that an organization is actively pursuing diversification, which can often take place by sourcing products from international markets (Narasimhan and Kim, 2002).

Furthermore, urban experimentation considers both technical and social components, making it highly influential within socio-technical regime shifts. As Castán Broto and Bulkeley (2013a) highlight, urban experimentation can lead to advancements within technical innovation (designs and technology) as well as social innovations (such as policy and financial mechanisms). As Patel, et al. (n.d.) highlights, an influential facet of urban experimentation is

the way in which it cultivates and expands social networks, through which social learning can take place.

One prominent feature of this is the way in which urban experimentation can be implemented as a means to create alternative pathways where local level transformation is otherwise absent (Patel, et al., n.d.). Adding to this, Swilling, et al. (2013: 10) emphasizes the necessity of urban poor organizations being able to access "knowledge networks" that assist the processes of innovation. By accessing "knowledge networks", urban poor organizations are able to develop institutional arrangements that draw on the experiences and knowledge of local communities. Once again emphasizing the important role of public participation and community engagement.

Drawing on the experiences and knowledge of local communities establishes a bottom-up approach to governance by providing a platform for the co-management and coproduction of knowledge, through participation. Co-managing and coproducing knowledge through participation can be incorporated into informal settlements as a powerful tool for including the otherwise marginalized poor; to experiment, imitate and/or learn from new technologies in ways that surpass formal processes, from which they might normally be excluded (Pelling, et al., 2008). As Bos and Brown (2012) highlight, this social learning can result in foundational changes in norms, values, goals, operational procedures and actors that govern the decision-making processes and actions.

In the context of South Africa, urban experimentation has resulted in some of the most innovative policy and institutional developments – some examples being integrated development planning, cross-subsidization of urban services, and infrastructural projects to assist with social integration (Simone,

2006). These developments have made considerable headway in redesigning highly fractured post-Apartheid cities in the country, with limited resources available and the enormous challenges still embedded from the Apartheid regime (Simone, 2006). This is highlighted and argued by Radmore (2015: 1), "that African urbanism has opened up a conceptual and empirical space to explore social enterprise models that have the potential to bolster urban development and the upgrading of informal settlements."

In considering the role of iShack as an urban experiment, it deviates from the contemporary regime that depends on and supports a coal intensive centralised electrical system, provided by Eskom. A system in which the poor are either excluded or marginalized based on their financial ability to afford and access electricity; as well as relying on the ability of the state to provide this basic service and the associated infrastructure. It provides a means by which low carbon energy transitions can challenge both the regime and notions of development and justice, by the way in which it influences issues of access and affordability for the poor.

2.4. Intermediaries

Increased rates of urbanisation have resulted in greater pressures being placed on urban areas, from which cities are being assigned greater responsibilities to shape technology and innovation (Hodson and Marvin, 2009). Hodson and Marvin (2009) argue that this has led to the development of intermediaries, which can be characterised as transition managers, as they often take on the role of shaping technological transitions.

Farla, et al. (2012: 996) argues that innovation and transitions are not unintentional but are strategically shaped by actors, and that changes within a socio-technical regime "can often be traced back to strategic interventions" by these actors. Guy, et al. (2011: 157) demonstrates that these intermediaries often carry out these interventions, as they are "thinking beyond the capacity of the state and can contribute to sustainable practice."

Intermediaries have two primary functions. The first of these is a process of developing a particular understanding of the context in which the intermediary finds itself, and then to position itself between this context and technological possibilities (Hodson and Marvin, 2009). This creates windows of opportunity from which intermediaries are able to "re-think" city contexts through technological transitions, which in turn opens up new points of intervention (Hodson and Marvin, 2009).

The second function of an intermediary relates to developing social networks that position the intermediary favourably, through the strengthening of relationships with specific actors or the strategic placement of actors by the intermediary itself (Hodson and Marvin, 2009). As Hodson and Marvin (2009) highlight, this can take place at various scales, from the local to the national, as well as the private, public, government or non-government spheres, with these actors coming from a variety of institutional settings.

Intermediaries have three key characteristics. The first is that they aim to establish sustainable transitions through long-term changes, by mediating consumption and production (van Lente, Hekkert, and van Waveren, 2003). van Lente, Hekkert, and van Waveren (2003) highlight that this takes place by

changing the way private firms, research institutions, public agencies and intermediaries operate and innovate.

The second characteristic is that an intermediary act's as a mediator - between different stakeholders, funders, and interests (e.g. policy and social) (Hodson and Marvin, 2010). The final characteristic is that an intermediary tries to manage different priorities (that of a community with that of local government for example), as well as the production and application of transitions (Hodson and Marvin, 2010).

The establishment of intermediaries is central to providing a space that is autonomous from both urban governance and socio-technical regimes, in which discussions around competing priorities can take place, broader social interests are identified, and transitions are formed (Hodson and Marvin, 2010). It is within this context that a link can be made to the political ecology approach. An intermediary providing a space to discuss competing priorities is similar to the political ecology approach that supports the critical examination of claims, their validity, and investigates the necessity and/or alternatives to a transition (Lawhon and Murphy, 2011).

However, there are specific requirements needed by intermediaries to ensure that transitions and new innovations form. Hodson and Marvin (2010) outline seven necessities. The first two relate to securing broad financial support, to ensure that both long-term systemic programmes are implemented and job security is guaranteed for those working for the intermediary (Hodson and Marvin, 2010). The third attribute relates to securing and strengthening social networks, so as to secure resources and commitments, as well as clearly identifying different expectations and roles for all involved with the intermediary (Hodson and Marvin, 2010).

This is also crucial in clearly identifying and prioritizing social interests and plays an important role in establishing a "shared organizational view" – from which the coproduction of knowledge and community engagement can take place more easily (Hodson and Marvin, 2010: 483). This highlights the need to develop a culture of learning and adaptability, to efficiently face and overcome pressures, constraints, expectations, desires, etc. (Hodson and Marvin, 2010).

Fourthly, Hodson and Marvin (2010) argue that an intermediary must always ensure that its knowledge base is constantly being developed and re-developed, as transitions depend heavily on different forms of knowledge (technical, policy and local) and social interests, which are constantly changing and therefore need to be appropriately discussed, negotiated and integrated.

The fifth requirement is the development of communication forums, so that spaces can be set up in which different social priorities and interests can be discussed and negotiated (Hodson and Marvin, 2010). It is important then that an intermediary establishes a local presence, so as to effectively cultivate local networks, build trust and encourage local participation/buy-in. This would also help in the development and feedback of local knowledge and its integration into the long-term systemic programmes cited earlier.

The sixth requirement focuses on the image of the intermediary. It is important that the intermediary considers how it is portraying itself and how it is being portrayed to the various players involved with it, especially how they represent what they are doing (Hodson and Marvin, 2010). The way an intermediary position's itself within a community, and to its residents, can largely determine if trust is built between itself and the community and

whether its programmes/projects are received well and become successful.

Finally, an intermediary needs to consider expansion/replication. The development of indicators (as to how it would know if it was influential and viable beyond its context) and a plan (as to how it would replicate itself) is essential to longevity and adaptability, which can further enhance the scale and success of the intermediary (Hodson and Marvin, 2010).

2.4.1. Assessing an intermediary's effectiveness

The seven points listed above are critical to the development of an intermediary, but not necessarily key to its success. Hodson and Marvin (2010) argue that there are two factors influencing an intermediary's success. The first is the extent to which the aims and objectives of the intermediary are met over time, as well as in relation to its budget (Hodson and Marvin, 2010). The second is the actual uptake of the intermediary's aims and objectives as part of the practices within a system, which Hodson and Marvin (2010: 483) regard as a "contextual view" of the intermediary's effectiveness and success as an agent of change. This relates to aspects of social learning, through which foundational changes of values, goals, operational procedures and decision-making processes take place (Bos and Brown, 2012).

van Lente, Hekkert, and van Waveren (2003) go into greater detail as to the ways in which an intermediary can be considered an agent of change. Three primary processes, all concerned with innovation and transitions, stand out. The first way in which an intermediary can be considered an agent of change is how it stimulates a variety of new ways in which technology can be applied to a context and its possible future applications (van Lente, Hekkert, and van Waveren, 2003).

The second process is that of aligning actors with the intermediary and the objectives it wishes to carry out, which includes building new relationships and strengthening ones that already exist through forums (van Lente, Hekkert, and van Waveren, 2003).

The final process is concerned with supporting learning processes through urban experimentation and feedback mechanisms (van Lente, Hekkert, and van Waveren, 2003). These three functions, which the authors summarize as "articulation, alignment and learning," are the primary challenges that intermediaries face in perusing systems innovation and change (van Lente, Hekkert, and van Waveren, 2003; 10).

Furthermore, it is clear that the role of policy in supporting such intermediaries cannot go understated. van Lente, Hekkert, and van Waveren (2003) reiterate this exact point, in that policy instruments are to be in line with the characteristics of an innovation system, supporting its development, but they should not be regarded as solutions. Rather, policy should be used as a tool to create and assist learning processes that can lead to expanding innovation systems to contexts that experience the same challenges and restrictions (van Lente, Hekkert, and van Waveren, 2003).

The role of an intermediary is largely determined by its context, which can also influence the way in which an intermediary carries out the three processes listed above. More so, Edquist (1997) highlights that each national circumstance is unique, due to the historical path dependency of a nations state. van Lente, Hekkert, and van Waveren (2003) argue that to a large extent policy instruments [need to] line up with the characteristics of a country's innovation system.

The next section focussing on the South African context will provide an overview of South Africa's political economy and how this has largely determined the states dependency on coal, and how this has naturally shaped sectoral, political and infrastructural systems. Unsurprisingly, this has also influenced the role of intermediaries, like iShack, that pursue sustainable, renewable, and alternative sources of electricity.

3. South Africa's energy path dependency and the iShack Project

3.1. Tariffs and access

Baker, Newell, and Phillips (2014) explore the political economy of South Africa's energy transition, which is largely determined by the country's economic model that relies almost solely on coal-generated electricity. However, from an economic and environmental point of view, this form of electrical generation is no longer economically viable or environmentally sustainable. These inadequacies are contributing towards the increasing development of alternative, sustainable energy practices; infrastructural investments and political agendas that promote clean energy transitions (Baker, Newell, and Phillips, 2014).

The South African government has locked itself into a dependency on Eskom to support the economies dependency on energy intensive growth, supplemented by the extraction of low-cost coal that generates 96% of the nation's electricity (Baker, Newell, and Phillips, 2014). Continuous blackouts and mine closures crippled the country in 2008, and continued again beyond 2012, costing the South African economy US$ 7.1 billion (Swilling and Annecke, 2012: 227).

This forced the National Energy Regulator (NERSA[6]) to approve dramatic tariff increases. A three-year tariff increase of 25% with further increases of 8% to 2018, have seen electricity prices surge to 65.51c/kWh in 2013/2014 and could be as high as an average of 110c/kWh by 2020 (Baker, Newell, and

[6] It regulates the electricity, piped-gas and petroleum pipelines industries in terms of the Electricity Regulation Act, 2006 (Act No. 4 of 2006), Gas Act, 2001 (Act No. 48 of 2001) and Petroleum Pipelines Act, 2003 (Act No. 60 of 2003). Retrieved from http://www.nersa.org.za

Phillips, 2014). Not only will this have a distressing impact on the manufacturing and industrial sectors of the economy, but the ripple effects will also be felt across all social classes, especially the poor.

Baker, Newell, and Phillips (2014) argue that the country has already experienced a transition phase, from an era of 'energy opulence' to a period of constraint, due to environmental, economic and infrastructural limitations. Overcoming these limitations will involve addressing the economic disadvantages of marginalised populations – a key feature in addressing the infrastructure of historic socio-technical regimes such as Apartheid (Baker, Newell, and Phillips, 2014). There needs to be an active effort to bring about purposive transitions within the private sector, to reshape the elitist gains of historic Apartheid infrastructural systems, which have a massive impact on the ability of poor South Africans and cities to respond to energy poverty (Hodson and Marvin, 2010).

Key to this is ensuring that jobs are created while also addressing the issue of energy poverty. Baker, Newell, and Phillips (2014) emphasise that the 'green economy' needs to be embraced in addressing the issue of unemployment and poverty, and be seen as an opportunity to create low-skilled jobs while also securing clean and renewable energy for the marginalised poor.

3.2. iShack as a case study

The iShack Project is an urban experiment that evolved out of the research and engagement of students from the Sustainability Institute in Stellenbosch, with community members of Enkanini. This engagement started in 2011 while the iShack Project was conceptualised in 2012, with the first demo 'ishack' being built and retrofitted. The Project at that time was involved in

addressing multiple issues, such as sanitation and building materials, but has since turned specifically to electrification.

The first pilot installations of the solar home systems took place in Enkanini in April of 2013, with funding coming from the Gates Foundation. From that point on, installations began in October of 2013 for the entire community, which the Green Fund (on behalf of the Department of Environmental Affairs) funded. For the first two years of the iShack Project, all of the solar home systems and appliances, the solar panels, DB boxes, batteries, TV's, light bulbs, and switches, came from one supplier, SSS (Specialized Solar Systems).

These solar home systems are installed by trained "iShack Agents", who are all residents of Enkanini. Once a client has signed their contract, specifying which package they would like (the 'Free Basic' or Contract), the Agents install the solar home system into their shack with the associated appliances. These solar home systems and their appliances are moved from the Sustainability Institute in Stellenbosch, where the iShack head office is situated, to the iShack Hub (iShack's main base of operation in Enkanini) on the day of installation. The systems and appliances are then delivered to the appropriate client, based on which package they signed up for.

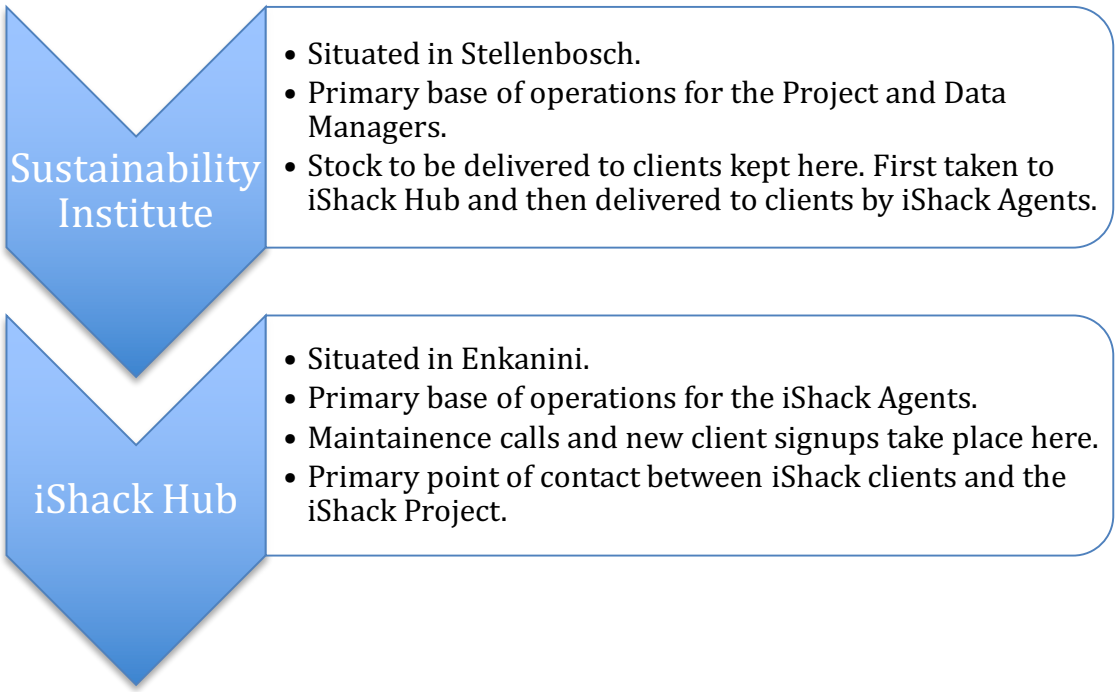

Figure 4 – The institutional arrangements of the iShack Project.

The business model of the iShack Project relies heavily on the battery units, as they store the electricity generated by the solar panels. Stock deliveries often involved the recharging of batteries, which normally have a lifespan of around 2 years, but do occasionally need to be boost-charged on a high current rate for a short period of time. They would need to be recharged as they would either be overcharged or completely drained by clients who misused the system. These batteries were then delivered to iShack clients, and installed by the iShack Agents in the client's shack.

The systems and their monthly cost vary, depending on the package that a client wants. In 2015, the Stellenbosch Local Municipality agreed to give the Free Basic Electricity right to the iShack Project, essentially covering all baseline-operating costs, and allowing the Project to offer the 'Free Basic' package to residents in Enkanini. As depicted below in Figure 5, the 'Free Basic' package does not have a monthly fee, only an installation cost, while

'Contract' clients pay an installation cost and R130 a month if they have a TV, or R80 if they only have lights. However, as highlighted below, there are benefits associated with these monthly contract costs.

	'Free Basic' Pay as you go	Contract
Maintenance with callout	R30 per maintenance callout Requires positive iSolar Account balance before visit.	FREE maintenance callout
Battery replacement	Paid by client Client can choose which battery size to take next.	Free Unless battery is overused and dies early.
Service fees	None Only voluntary savings in iSolar Account.	With TV: R130 per month Lights only: R80 per month
Default on payments	Possible If client misses payment, they will be switched OFF and possible repossession of system.	Possible Moved to FB-PAYG after 14 days and switched ON (after FB-PAYG induction) If the contract client has paid their monthly service fee for more than 24 months leading up to them defaulting, they can keep their TV. If less than 24 months, the TV is repossessed and the clients are encouraged to complete payments.

Figure 5 – A diagram explaining the differences between the 'Free Basic' and Contract packages.

Delivering the solar home systems to clients allowed me to travel with the iShack Agents extensively, throughout the various sectors that make up the settlement - as highlighted in Figure 7. Overall, I spent at least 3 hours in

Enkanini daily and also made some trips to Kayamandi (a neighbouring low-income suburb). Figure 8 is a map of Enkanini and Kayamandi, highlighting the layout and positioning of these two settlements in relation to one another.

I was also able to see how these solar home systems are installed, how malfunctioning systems are replaced/maintained, and how troubleshooting issues are overcome – as highlighted in Figure 6. This also afforded me the opportunity to observe how the Agents and either manager (project manager and data manager) interacted with the clients and community members.

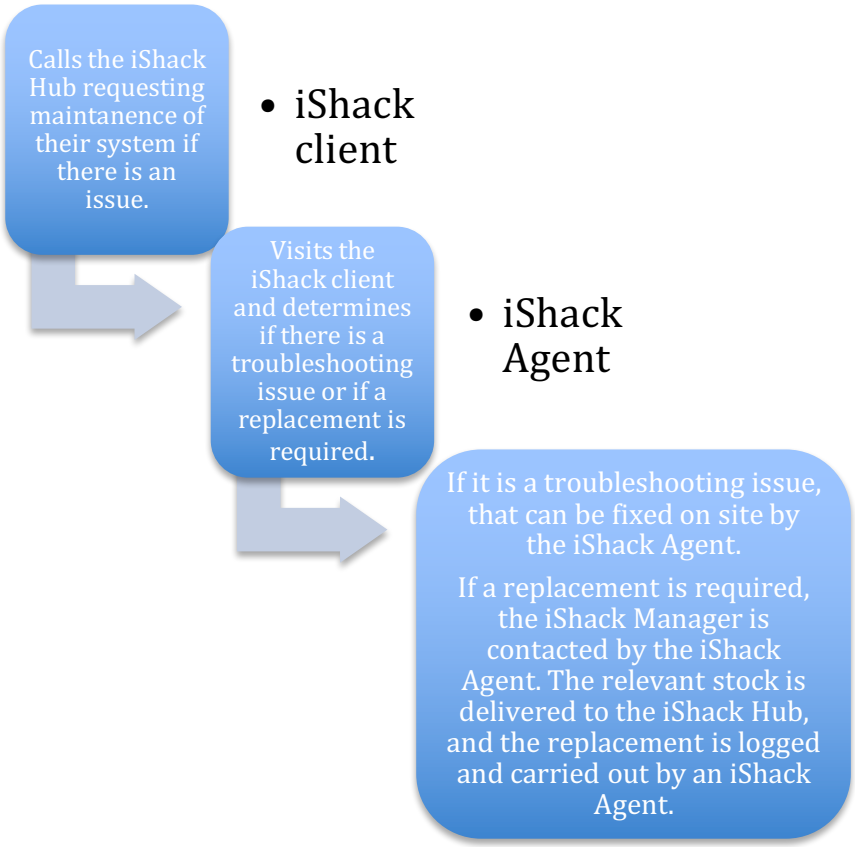

Figure 6 – A diagram explaining the process of carrying out maintenance or replacing a solar home system.

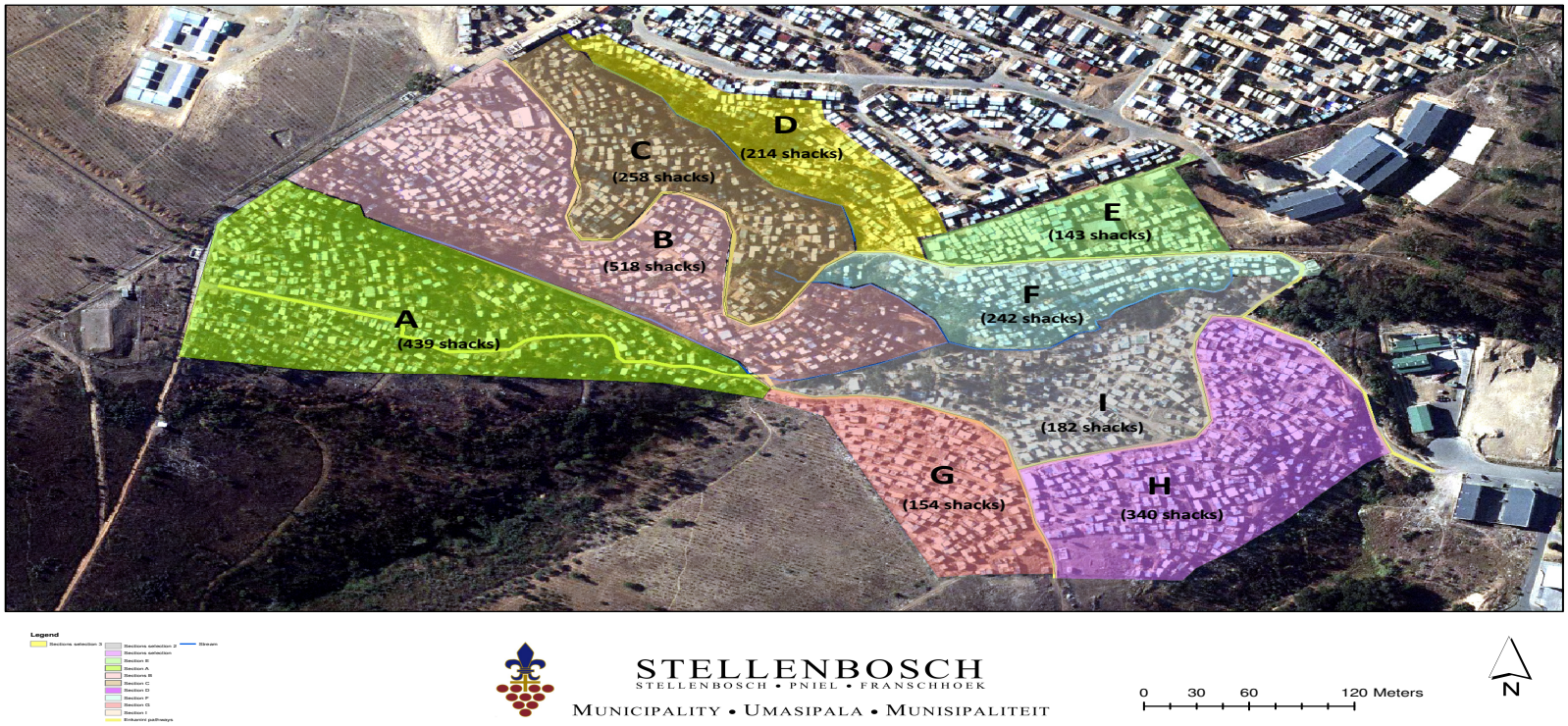

Figure 7 – A sectoral map of Enkanini, highlighting the way in which the settlement has been broken up.

Enkanini is broken up into various sectors. This map only highlights nine of them because at the time Zola section ("Z sector") had not yet formed. Zola is now found between the D and E sectors on the map. This system was created so that shacks could be numbered and identified.

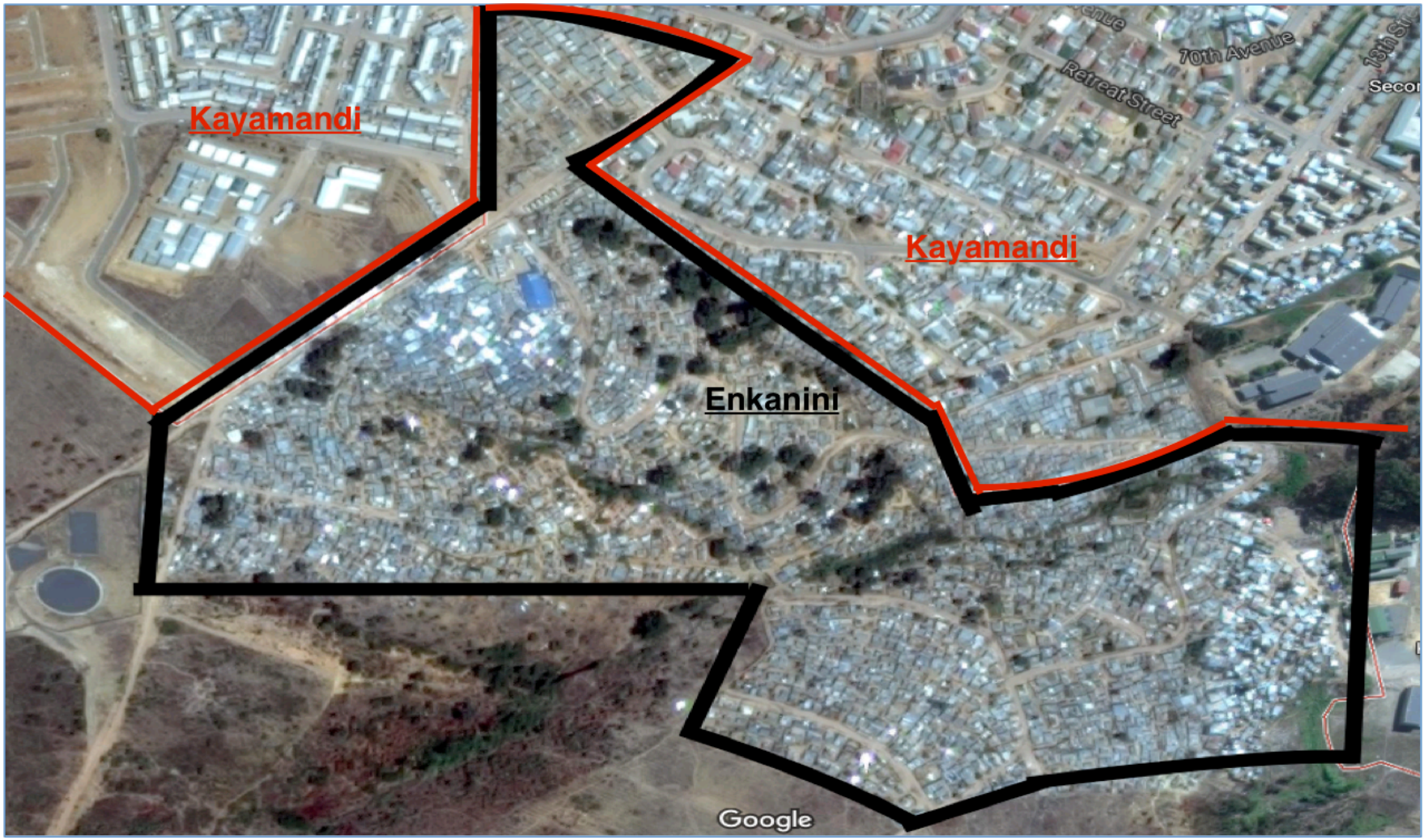

Figure 8 – Enkanini, found below Kayamandi (Google Maps, 2017).

The iShack Project will be used as a case study to explore the concepts of urban transitions theory, urban experimentation, the importance of environmental justice, and the role of an intermediary in relation to low carbon energy transitions in an informal settlement. The debates regarding South Africa's energy politics, as outlined in the literature, indicate that there is clear potential to shift the power dynamics within the country's landscape.

As the literature highlights, a shift from an era of 'energy opulence' to a period of constraint means that addressing the economic disadvantages of marginalised populations is key to overcoming these constraints. With the increasing development of alternative, sustainable energy practices, it is possible to challenge the priorities and interests in a coal based centralised electrical system at the regime level, with the introduction and implementation of innovative technologies in renewable electricity generation at a niche level (Baker, Newell, and Phillips, 2014).

As Baker, Newell, and Phillips (2014) argue, agency is one of the primary factors thought to facilitate this shift within policy debates, with the political ecology approach placing emphasis on the ability of 'bottom up' niche innovations to encourage sustainability transitions. Of particular interest are the links between the iShack Project and the literature, such as Geel's (2011) description of a 'radical innovation', Lehtonen and Kern's (2009) depiction of a new technology/market or idea/practice that deviates from the dominant regime, as well as being an independent renewable energy power producer (Baker, Newell, and Phillips, 2014).

Furthermore, this dissertation will explore iShack's delivery of subsidised services to the poor, as a means to investigate the extent to which the niche innovation meets the energy needs of the Enkanini residents, which relates directly to the financial considerations of access and affordability.

Jaglin (2008) argues that it is often the case that uncoordinated market strategies are to blame for leading poor communities into a 'lock in' with substandard service delivery. By analysing the relationship between FBE/FBAE and the creation of just cities, greater insight may be established as to how social enterprises and government can work together to define the quality and nature of services and developmental objectives (Jaglin, 2008).

Consequently, this project contributes to literature on urban transitions and aims to provide insight on a municipal delivery system with greater flexibility, by considering social enterprises as viable regional entities that can take on the activities previously carried out by the state (Jaglin, 2008).

4. Methods and Approaches

The methods and approaches for this dissertation are informed the two conceptual frameworks (MLP and the political ecology approach). These frameworks inform the research questions, and the process of data gathering. As highlighted in Annexes 2-4 on pages 121-123, these frameworks helped structure the interview guides and provided a lens through which each of the research questions could be answered by achieving a desired outcome. The second component is the methods used during fieldwork as part of the ethnographic research, including participant observation, interviews and photography.

4.1. Fieldwork approach

Before drafting the proposal for this dissertation, an agreement of collaboration had been established to work with the iShack Project, under the guidance of its project manager. It was important to remember throughout the entire process of this dissertation, that I was working with a social enterprise that is well established and has its own 'way' of doing things. Respect for the iShack Project, its business structure, dealings, and the guidance and opportunities provided by the project manager was maintained throughout the fieldwork component of this dissertation.

The fieldwork component of this dissertation took place in the November/December 2016 holidays. Two weeks were spent working within the Enkanini community and neighbouring Kayamandi settlement, gaining greater insight and understanding of the role of the project and data managers, the iShack Agents and the daily dealings of the Project with its clientele. Accompanying the iShack Agents during their maintenance calls

allowed me to witness their interaction with these clients and afforded me the opportunity to navigate the informal settlement.

Working closely with the managers and iShack Agents over these two weeks influenced the majority of my interactions, insights and interviews. This may account for any bias the reader may feel I have for the Project. However, from my experience and findings, I maintain that the iShack Project represents a viable means by which energy poverty and inefficient service delivery can be addressed in informal settlements, through low carbon energy transitions.

4.2. Analytical tools

The advantage of using MLP as a conceptual framework is its ability to broadly explore and understand the 'systems innovation' that takes place when transitions occur. Alongside the political ecology approach, which provides an in-depth look at the experiences of those making up the 'social' aspect of socio-technical transitions, as it focuses more specifically on the various stakeholders involved. Consequently, the political ecology approach highlights prominent components of agency and power relations.

Both of these frameworks have already been highlighted and discussed. However, concentrating specifically on their role and effect on the fieldwork component of this dissertation, as well as how they influenced data collection, both informed the ethnographic component. Particularly the interviewing process and participatory observation, as both focus specifically on the 'social' aspect of socio-technical transitions and were appropriate for engaging with all stakeholders concerned.

They largely influenced the questions asked during the interviewing process and helped discern the desired outcome, by identifying and understanding the lived realities, values and interests of those living in townships, and those working on behalf of an intermediary. Whether the question was gathering data on the gap between policy and delivery or identifying policy outcomes or windows of opportunity, it highlighted the 'social' aspect of socio-technical transitions.

This is highlighted in Annexes 2-4 and can be analysed in greater detail on pages 121-123. They also stressed the importance of going into Enkanini with a social lens, influencing participant observation by emphasizing the importance of observing the social interactions between the residents of Enkanini and the iShack staff.

4.3. Ethnographic research

Whitehead (2004) describes ethnographic research as being concerned with the study of people in their environment, which normally takes place through methods such as participant observation and interviews. In the case of this dissertation, this is central in identifying and understanding the lived realities, values and interests of those living in townships, specifically the residents of Enkanini. It is central in answering the research questions of this study, in realizing all three objectives, and to adequately investigate the factors that influence the implementation of low carbon energy transitions in informal settlements in South Africa.

Participant observation and interviews allowed me to collect data on the broader 'conditions', 'environment' and 'pressures' evident in the Enkanini community, and how these have come to influence the low carbon energy

transitions there. They also helped identify stakeholders and their positioning within the broader landscape of regimes, and more specifically in relation to iShack. Participant observation and interviews generated the data necessary to allow for MLP and the political ecology approach to be applied in analysing and discussing this material.

4.3.1. Participant observation

Participant observation can be considered a qualitative method in which researchers learn the perspectives of the 'study population' (Mack, et al., 2005). It maintains that there are multiple perspectives within a community and aims to know and better understand them (Mack, et al., 2005). Within the community setting, the researcher makes objective notes on all accounts and observations, within informal conversations and interactions – in this way, it also contributes to strengthening the interviewing process (Mack, et al., 2005). It provides greater insight into the economic, social, environmental and political context of a community, as well as the relationships and interactions between ideas, norms, people and events (Mack, et al., 2005).

My notebook and cell phone allowed me to record all observations made during fieldwork. It helped me understand and frame the ways in which the iShack Agents and the residents of Enkanini understand, experience and negotiate the space around them. It was employed largely while accompanying the iShack Agents during maintenance calls or installations.

Participant observation allowed me to identify the stakeholders involved with the iShack Project, which strengthened the interviewing process. Furthermore, by observing the social interactions between iShack staff and Enkanini residents, I was able to observe differences in agency more closely,

which helped structure the interviews differently. The questions I asked each of the three stakeholders differed because the desired outcomes for each stakeholder differed. Participant observation was the primary means through which insights and accounts were brought to the forefront, as to the ways in which low carbon energy transitions have influenced norms, values and procedures within the community and contributed to change.

Simply making observations during the first week of fieldwork, before interviewing anyone, proved advantageous in the sense that the residents had then seen me working within the community. As a result, I was not completely foreign to them when I eventually conducted the interviews. It was during this week that I was able to help with stock exchanges, deliveries, and installation and maintenance calls. Being involved in these procedures allowed me to learn about the process of delivery, from iShack to Enkanini, in greater detail, from which I better understood the institutional arrangements of iShack as an intermediary. This provided data on the gap between policy and the delivery of energy solutions to Enkanini, as well as better understanding the role of intermediaries, such as iShack, in the development and delivery of niche innovations; generating data for research questions 1 and 2.

4.3.2. Interviews

As highlighted by Clifford, et al. (2016), while the interviewer has prepared a set of predetermined questions, semi-structured interviews can unfold in such a manner that participants are able to raise and explore issues they themselves feel are important. This would identify the real issues and concerns of the end-users. Furthermore, the authors highlight four important considerations for interviewing participants.

The first is to be mindful of different languages, in considering written translation or using interpreters (Clifford, et al., 2016). Secondly, being mindful of power relations and positionality. As Bourke (2014) explains, always being mindful of one's own positionality can be described as reflexive. Furthermore, he argues that reflexivity can extend to the methodological approaches implemented in research, as a continuous process of 'self-analysis', in determining where you stand in relation to 'the other' (Bourke, 2014).

As Merriam, et al. (2001) highlights, this has two predominant implications. The advantage of being considered an 'outsider' is the ability to be curious and not be aligned to any subgroups (Merriam, et al., 2001). This allows the researcher to ask provoking questions, which usually results in receiving more information in the process. However, being considered an 'insider' normally results in a researcher being accused of being bias, or not asking the provoking questions (Merriam, et al., 2001).

The primary concern regarding my own positionality was that I am a white male university student coming into a community with its own rules and values. How this would influence the way in which community members viewed me was yet to be determined. Perhaps as an 'insider' due to my relationship with iShack and its project manager? And how this would influence the interviewing process was also uncertain.

However, accompanying the iShack Agents as they did their maintenance calls was crucial in helping me navigate the informal settlement, read social cues, and always ensured that there was an interpreter nearby. Accompanying an iShack Agent and having them as an interpreter did raise

its own sets of concerns - as to how this might make an interviewee timid. Yet, all the iShack Agents are residents of Enkanini themselves. If anything, this strengthened the interview process, as the interviewee always had a member of the community (someone they trusted) acting as the "middleman" between them and me. This definitely influenced the setting of each interview and helped limit/equalize any shifts in power relations and positionality.

Thirdly, in selecting participants to be interviewed the overarching concern may be to ensure that the group is either random or representative (Clifford, et al., 2016). However, Clifford, et al. (2016) emphasizes that the central purpose of an interview is to better understand the lived experiences of individuals and how they make sense of their own lives, which will take place regardless.

Finally, the issue of where interviews take place influences the flow of discussion, and so identifying a neutral, informal and easily accessible location is key (Clifford, et al., 2016). As Clifford, et al. (2016) confesses, it would not be wise to have an interview on quality of service offered by a local council, in local council offices.

4.3.2.1. Stakeholders

This dissertation required interviews with three stakeholders: the iShack Agents (Enkanini residents employed by iShack), the iShack project and data managers, and the Enkanini residents (the 'end users'/iShack clients). These three stakeholders are the main actors involved with the intermediary (iShack) and are the primary influencers of the transition that aims to provide sustainable, renewable, affordable and reliable electricity to Enkanini.

Government officials were not consulted as a fourth stakeholder, considering that the Stellenbosch Local Municipality already has a formal agreement with the iShack Project by providing the FBE grant – through which the Project is able to deliver the Free Basic Solar package. Furthermore, the policy documents highlighted in this dissertation are illustrative of the governments concern with "energy support matters for poor households", as well as representing the government's aim to "address ways and means through which it can bring about relief" to these households, and make improvements through "the efficient utilization of energy and savings interventions" (DME, 2003; 5-6). The relationship between the iShack Project, as an intermediary, and local government is not within the scope of this dissertation, but it holds the potential for another research project.

The interviewing process was divided into two different groupings. The first being iShack staff members (the managers and Agents) and the second being community members. This was done to collect specific data from either grouping for two different research questions. However, the interview guides themselves had largely been influenced by the conceptual frameworks mentioned above. Each guide focuses on a specific component ("research question") and then poses questions to generate specific data from either grouping.

Annex 2 on page 121 highlights the group guide concerning the gap between policy and delivery. The Project staff members largely provided data on the role of an intermediary delivering services to an informal settlement, while community members essentially identified the window of opportunity that the iShack Project utilized.

Similarly, Annex 3 on page 122 highlights the group guide concerning the development and delivery of niche innovations to an informal settlement. Project staff members provided the technical data of the niche innovation itself, while community members highlighted the social benefits and impacts of this innovation.

4.3.2.2. iShack staff members

My cell phone was used to document all thoughts, interviews, 'off-the-cuff' questions and conversations. This proved useful in linking observations, interviews, and the lived experiences of the community to the literature. If a client struggled to speak English, my questions and their answered with translator by an iShack Agent. I then transcribed all of these interviews into a separate document and read over it. This allowed me to analyse the data holistically, identifying different themes or common threads. Clifford, et al. (2016) point of where interviews take place was also a major consideration in creating a neutral and easily accessible location. The stakeholder group I was interviewing determined the way in which that interview was setup.

For example, interviews with the iShack Agents were both formal and informal. The formal interviews took place one on one in the Enkanini iShack Hub during their lunch breaks. The purpose of the formal interview was to ensure that all the questions I had set up for them would be answered by the time my fieldwork was complete. The informal interviews took place as I asked them questions while they worked, or as we navigated the settlement to a maintenance call. There were a few instances whereby the iShack Agents initiated these informal conversations.

However, most of the interviews with iShack's project manager were formal and structured, as they were moments of intentional guidance and consolidation. Specific times were setup for formal interviews, in which I also brought back new questions and observations from being in Enkanini. He represents a prominent voice as the project manager of an urban experiment, implementing niche innovations in an informal settlement.

4.3.2.3. Community members

Interviews with the residents of the Enkanini community were semi-structured, as the questions I asked differed based on their age, gender, how many people lived in the household and which 'package' the client was on. All of these interviews took place in Enkanini, normally in their home – therefore making it a neutral and easily accessible location. The expectation was that this would make the residents feel more comfortable and confident, and they would share more willingly.

Focusing on these three stakeholders will ensure that both the aim and objectives of this dissertation are reached. The interviewing process also provided an opportunity for the community to voice their opinions on this urban experiment and discuss the impact iShack has had on their lives. This could be a vital component of encouraging government to invest in and expand low carbon energy transitions in townships.

The opinions and insights of those who were interviewed are represented by codes to ensure their anonymity. Please consult Annex 1 on page 120 to familiarize yourself with these codes.

4.3.3. Photographic Evidence

Photographs accompany many of the findings and insights highlighted from the participatory observation and interviews. As Schwartz (1989: 120) argues, photographs can be considered records, and reproduce the reality of a situation in an "unmediated and unbiased" way. Furthermore, photographs also add to the participatory observation process, as they record patterns of daily activity that support the observations taken down as field notes (Schwartz, 1989). Additionally, Schwartz (1989) highlights that during her research, the camera became a means to engage in the social life of the community. It provided an obvious reason to initiate informal conversations with people who were drawn to her as she took photographs.

Photographs were taken throughout my time spent in Enkanini, and played a fundamental role in documenting interactions between various stakeholders during informal day-to-day activities, days spent with the iShack Agents during installation and maintenance calls, and acts as a point of reference for the observations laid out in this dissertation. However, I did not find that photographing drew people into conversation with me, as I asked for permission first before taking a photograph, due to research ethics.

4.3.4. Policy Analysis

As described by Geva-May and Pal (1999), policy analysis helps determine which policies are most likely to achieve a given set of goals. Furthermore, Dunn (1981: 60) considers policy analysis a "method of enquiry that can transform policy-relevant information to help resolve public problems." Within the scope of this dissertation, the FBE policy will be analysed within the context of its relationship to the iShack Project and its impact on justice.

Specifically, how the FBE policy has influenced the introduction of low carbon energy transitions to Enkanini, and how this creates a possibility of conceptualising development and energy security differently within the context of policy.

Ritchie and Spencer (2002: 305) argue that policy analysis forms part of qualitative research methods through the inclusion of case studies and interviews with community members, to better understand "complex behaviours, needs, systems and cultures." The authors suggest a framework, an analytical process, which helps with qualitative data analysis. Two key components of this framework are "familiarisation" and "identifying a thematic framework" (Ritchie and Spencer, 2002: 312-313). Familiarisation involves analysing the data, reading transcripts and studying observational notes, while identifying thematic frameworks consists of pulling common threads and emergent issues together (Ritchie and Spencer, 2002).

This framework influenced the structure of the interview guides, by dedicating each one to a particular research question, and posing a question with a particular outcome in mind. This allowed me to identify key issues, concepts and themes, which helped establish the relationship of the FBE policy to the context of Enkanini, as well as to the iShack Project (Ritchie and Spencer, 2002: 313). This provided insight into the impacts of the FBE policy, and related directly to issues of access and affordability.

The policy makes it clear that government recognizes that "poor households do not benefit from the same efficiency and environmental benefits afforded by electrification due to the severe poverty" (DME, 2003; 5). This clearly highlights concerns of environmental justice and ensuring the fair distribution

of both environmental benefits and its burdens. As a result, the policy aims to address ways through which government intervention can bring about some relief to the poor and guarantee socio-economic benefits, highlighting that this issue of justice is multi-faceted and not only to do with the environment (DME, 2003).

More so, the policy states that it recognizes this benefit (the allocation of 50kWh per month) can increase through "the efficient utilization of energy and savings interventions for the same amount of energy" (DME, 2003; 6). This creates a window of opportunity, encouraging transitions and niche innovations to increase this benefit through "efficient utilization of energy and savings interventions."

These are two agendas that the iShack Project aspires to fulfil and constantly improve, through continual innovation and the changing of their Client Management Policy (2017) to improve saving schemes. As the reader will see, technological innovations, such as "Flash" and the "Flash wallet" have led to improved saving interventions, while the introduction of new BBOXX units have contributed to greater levels of efficient utilization.

Ultimately, change in behaviour is the real indicator as to whether an urban transition has been successful or not. While looking at the end-users, and considering any possible change in their behaviour, this dissertation sets out to consider the FBE and FBAE's influence in the scale of uptake of the services provided by iShack, as an indicator of an effective urban experiment.

5. Findings

The findings of this dissertation are presented under different sections, each relating to one of the three research questions asked. Concerning the first research question, on the gap between policy and the delivery of energy solutions, residents of Enkanini describe their context and feelings around the topic of service delivery in their community. This highlights how a window of opportunity has formed, through which an intermediary such as iShack has stepped. The social benefits linked with the services of the iShack Project are discussed. Concluding with an analysis of iShack's success as an intermediary, and what members of Enkanini and other informal settlements have to say about this.

Secondly, relating to the role of intermediaries and urban experimentation in the development of niche innovations, the newly introduced BBOXX units and their associated benefits will be discussed. Subsequently, the role of community engagement and public participation will be highlighted in explaining how these processes have influenced innovative changes within iShack's internal Client Management Policy (2017) and how this has led to other innovations.

iShack's contracting process will be used as an example of how it has influenced the social learning process. It relates to the necessity of urban poor organizations accessing "knowledge networks" that assist the processes of innovation (Swilling, et al., 2013: 10). Drawing on the experiences and knowledge of local communities, through public participation and community engagement, is central to this (Swilling, et al., 2013). Furthermore, public participation and community engagement are means by

which environmental justice is better understood and considered, by theorizing "the lived realities of actual people, places, and problems" Sze and London (2008: 1347).

Finally, relating to the relationship between policy and the creation of just cities, the impacts of the FBE subsidy on the iShack Project will be discussed. Subsequently, the ways in which the iShack Project have addressed issues of access and affordability will be addressed, as well as how community engagement and public participation have enhanced iShack's efforts to improve the poor's ability to access and afford electricity. iShack's technological innovations, such as "Flash" and the "Flash wallet" will be discussed, as innovations that have improved access and affordability for the poor. This is then linked to the FBE policy, and a clear connection between policy and technological innovation can be noticed, as well as policy and justice, within the realm of energy poverty.

5.1 Dissatisfaction with poor service delivery

The first research question is concerned with the gap between policy and the delivery of energy solutions to informal settlements. Jaglin's (2008) consideration of social enterprises as viable entities that can take on activities previously carried out by the state largely informs this section. The author argues that social enterprises have stepped into this space in an attempt to work with the state in bringing about environmental justice in rural communities through efficient service delivery (Jaglin, 2008). Extracts from interviews conducted with residents of Enkanini, as well as iShack Agents, highlight the evident dissatisfaction with "empty promises" made by government and the clear need for alternative delivery mechanisms.

IC 1 (08/12/2016) made it clear how the government had made "empty promises because I think for 4 or 5 years now they promised to electrify Enkanini, but they never do that. So, I like for the iShack to take over what the government said they would do. I don't feel like I am a forgotten person anymore because now I have electricity, just like those people who are connected." Similarly, IC 3 (07/12/2016), who has been in Enkanini for 10 years, longer than that of IC 1 (08/12/2016), was less hopeful: "I don't think they'll give us electricity because for 10 years they've said we must vote and they'll give us electricity, but that doesn't happen. There is electricity over there [Kiyamandi], then we buy the wires, then we plug somewhere there and we can get electricity [illegal connections]. But I don't think they'll get it for us because long time they've been promising but its empty promises. You can see, even the road is 'deurmekaar'."

There is an evident lack of infrastructure within the community of Enkanini – lack of sewerage pipes, gutters, roads, streetlights, etc. This can often pose as an infrastructural restriction to local government wishing to service an informal settlement. It is also evident that this has led to a feeling of abandonment on the part of the residents.

During my observations however, it became evident how these concerns with government and the feeling of abandonment had led to various community and individual initiatives and innovations, which had taken place autonomously from the iShack Project. Residents were laying down their own water pipes, gutters, sewerage tanks, etc. because they could not rely on anyone else.

5.1.1 The social benefits of the iShack Project

In contrast to the dissatisfaction shown towards government and lack of service delivery, the services provided by the iShack Project have brought about tangible social benefits for the residents of Enkanini.

One of the iShack Agents described in an interview, that before the iShack Project came to Enkanini, the community "was like a forest. A dark place where people can't live in. Even at night you can't see your own finger. But now because we have this kind of electricity, even our spotlights, they are brighter than the Eskom spotlight. So, you can see everything. Even your street you can walk at night. Even the crime is not that much because everybody now can see what is happening in your neighbourhood. Not like before."

This highlight's one of the various social benefits brought about by the iShack Project. A greater sense of security has accompanied the introduction of this low carbon energy transition, and has made fundamental improvements for members of a settlement that do not even have street lights. Figure 9 depicts a spotlight above the doorway of a shack, which is one of three lights that a client receives with a solar home system from the iShack Project. This spotlight adds greater visibility at night-time for the residents. A big incentive for clients, as one female client warned me not to be in the community past 6pm, as that is when the "skollies" came out.

Figure 9 (Left)– A spotlight above the shack door (Glasser, 2016).

Figure 10 (Right) – iShack Agents installing a new battery for the client of the green shack (Glasser, 2016).

IC 2 (08/12/2016) described how the services of the iShack Project had also impacted family units within the settlement. "With the lights, I no longer have that fear when I leave the children alone here. I don't have that fear that the shack might get burnt. Since a lot of people here have got kids, I think it has helped them with the TV, so that the children cannot always be on the streets. Secondly, during this time of the year, there used to be a lot of fires here. And now I can say that the rate of fires has been minimized."

A mother in the community added to this point and explained how those who could not afford to send their children to school appreciated how their children could watch shows that taught them English and Afrikaans. It was one thing to hear this from a resident, but to actually witness a shack full of children, all crowded around a TV (as seen in Figure 11 below) during the week when they should be in school, was the proof.

Figure 11 – Children from the community gathering in the shack of an iShack client to watch TV (Glasser, 2016).

Another mother stated how fear of the children being electrocuted by wires that extended across rooftops and trees, due to illegal connections, had greatly reduced since the introduction of the solar panels. Figure 12 has already been shown, but it shows perfectly how the shacks that have solar panels on their roofs do not have any cables leading to them.

Figure 12 – Shacks that have solar panels on their roofs, with no electrical lines because there is no longer a need for them (Glasser, 2016).

It has already been mentioned, but the impact that this low carbon energy transition has had on shack fires in Enkanini has been significant. The frequency of these fires has diminished significantly as dependency on candles and paraffin gas has reduced with the introduction of the solar home systems. In every interview, either with the residents, iShack Agents, or the Managers, this was raised.

Despite this claim I witnessed two fires during fieldwork, both of which had started on the boarders of the settlement. Residents of the community had alerted the fire department and the fires were controlled and extinguished. The scale and damage of these fires brought to light the reality of these fires for the community. In both of these cases however, the residents blamed the fires on people who had been burning their rubbish on the outskirts of the settlement, where there is tall, dry grass. But it was important for the residents to highlight this point, that burning rubbish had started these fires. Not because of candles or paraffin, and they were therefore not regarded as shack fires.

Figure 13 – A fire that took place on the boarder of Enkanini on the 2 December 2016 (Glasser, 2016).

Figure 14 – The fire making its way down the valley, to the left of the settlement (Glasser, 2016).

Figures 13 and 14 are of the first fire I witnessed, just from different angles. It is evident in these pictures how the fire had started on the left of the settlement and had slowly started advancing down the valley.

Figure 15 – The second fire that took place on the 8 December 2016, started on the hill directly behind the settlement (Glasser, 2016).

With various social benefits associated with the iShack Project, it begs the question, "What is the possibility of a project, such as the iShack Project, expanding its operations"? As DM (06/12/2016) explained, the iShack Project, or similar projects, are eventually going to extend their base of operations past Stellenbosch and into Cape Town, simply out of necessity. "Extending on-grid infrastructure is becoming incredibly tedious; impossible really in some cases. I think the case of Enkanini is that it's got a history of being an illegal settlement; it's a settlement that is very inaccessible. It's on a hill, the terrain is almost impossible to come and start building electricity pylons and so I think it just comes about as part of necessity, and there's always pressure on the city to increase its service delivery and at times it can become quite violent. Solutions are being sought out from every nook and cranny. And I think one of the alternatives is definitely looking at what we are doing" (DM, 06/12/2016).

However, this has not restricted the iShack Project. Rather, the need for alternative delivery mechanisms has created a window of opportunity for the iShack Project. In contrast to poor service delivery and a sense of abandonment, the social benefits associated with the iShack Project are far reaching, and have created a sense of worth for those living in the community of Enkanini – who no longer consider themselves "a forgotten person anymore" (IC 1, 08/12/2016). It has provided a sense of security, means of education, keeps children off of the street, and has direct positive implications on the lives and health of those living in the settlement due to reduced shack fires and electrocutions.

5.1.2 Evidence of success

Further evidence of iShack's success includes the interest and requests from communities beyond its current area of intervention to replicate the delivery mechanism. As of December 2016, iShack had 902 clients and an aim of reaching 1500 by August 2017. The uptake of its services (i.e. the number of residents that want to sign up and use the service provided by iShack) is a primary indicator of iShack's success in Enkanini, as without the support and buy-in of the local community, no intermediary or niche innovation is successful. Furthermore, the social benefits that were discussed previously represent the positive social impacts the iShack Project is having, which has been noticed by residents of other informal settlements. This represents another form of success, not simply one based on uptake but one based on personal satisfaction. It signifies a transition from a sense of abandonment to one in which the actual needs and desires of those living in the community are being met.

DM (06/12/2016) explained that iShack's success in Enkanini and the innovative incorporation of the FBE grant which is making it all possible, has raised interests from local government institutions in Cape Town. However, understanding whether or not other communities could benefit from a project such as the iShack Project is another important indicator as to its success as a transition and urban experiment.

As the iShack Agents highlighted, they are continuously receiving phone calls from residents who live locally and internationally, asking if they can have the same services offered by the iShack Project in their settlements. The Agents

then have to respond and tell them that the iShack Project is currently only in its pilot phase.

Everyone that had been interviewed, across the stakeholder groups, maintained that other communities could benefit from a project like iShack. IA 1 (07/12/2016) and IA 4 (07/12/2016) revealed how Siqalo Court in Philippi, the Eastern Cape, KwaZulu-Natal and community leaders from Strand Nomzamo have been requesting iShack to come to their settlements. And the demand extends past the borders of South Africa to "a guy who contacted me from Harare in Zimbabwe, who wanted us to go and start this project there. They see our project; we are not only installing the systems, we also do the maintenance so we look after the systems. See that the systems are working so they are happy for that and they want that to go to their communities."

IA 2 (07/12/2016) said how the leaders from these other settlements "come here and ask for the iShack Project to come and help them there, because there is no electricity. There's not even and informal connection. Some others have contacted us from Paarl, Gwalaga next to Cape Town, Esqalo in the Eastern Cape, and the others in Franschhoek. There are a lot here, especially in Cape Town and the others are in other provinces. IA 3 (07/12/2016) highlights how people are calling from "Khayelitsha, others were in Kraaifontein. Some of them have relatives that stay here in Enkanini. They come and see and say, "I would like to have this."

This is the case for one of iShack's clients, IC 4 (08/12/2016), who has a sister that stays in "another community, Mbekweni in Paarl. They don't have electricity and are also interested to have a kind of project like this, to move

there." IC 2 (08/12/2016) explained how projects like the iShack Project could benefit other communities, and stated that it "depends on their [the communities] way of thinking. If the people can be educated, that we must all use the same thing, that is the solar, to substitute the paraffin."

It is clear from those on the ground, both the iShack Agents and clients, that there is a clear demand from other communities to have a project like the iShack Project replicated in their settlements. The social benefits are on display in Enkanini for others to see, and have clearly been noticed. This once again highlights the need for alternative delivery mechanisms, it highlights the viability of solar home systems as an alternative means of overcoming energy poverty, and it highlights the potential of low carbon energy transitions to challenge notions of development in informal settlements. The demand for iShack's services, far and wide, and their increasing number of clientele within their pilot community, displays the characteristics of a successful urban experiment.

5.2 Technological innovation

Intermediaries like the iShack Project play an important role in urban experimentation and the development and delivery of niche innovations. As it has already been shown, the lack of service delivery has provided a window of opportunity in which low carbon energy transitions have been introduced to an informal settlement, Enkanini. The technological innovations associated with the newly introduced BBOXX units, and their associated benefits, will now be discussed.

There is an important value of being 'technology agnostic' for the iShack Project. As PM (06/12/2016) explains, it "essentially means being 'technology neutral', which aids the process of experimentation, as it means the iShack team first tests solar home systems, appliances and different technologies "not just using whatever is cheapest but actually trying out technologies before we go "yeah, this is the one".

Figure 16 – A DBOX unit being installed in a client's shack (Glasser, 2016).

Figure 17 – A close-up of a DBOX unit from SSS. The LCD screen on top allows clients and iShack Agents to view readings such as battery voltage, charge, amps and the electricity that the solar panel is generating (Glasser, 2016).

However, for the first two years of the iShack Project, all of the appliances they could offer their clients, the solar panels, DB boxes, batteries, TV's, light bulbs, and switches, came from one supplier, SSS. Sourcing all of the appliances and solar home systems from one supplier served the Project well initially, as the logistics of dealing with one supplier made things far simpler. Though, there were also clear limitations and restrictions with regards to trying out different technologies, and as iShack's clientele base increased and the scale of operation reached a point of nearly 1000 systems, there were clear system limitations and technical issues. These limitations and technical issues were reflected and became more apparent as the iShack Project collected data and information on its clientele base and the system's in the field.

These limitations and technical issues reinforced the importance of being 'technology neutral' and the significant advantage of being able to match technology appropriate to a context. Essentially, being able to diversify their supply chain became an essential part of improving efficiency and adaptability. Furthermore, technology is constantly being improved to better cope with a changing world, and the freedom to experiment with this technology is crucial to strengthening socio-technical transitions.

PM (06/12/2016) emphasized how crucial it is to match the best-suited technology for a settlement's needs. "Cause you want to give them [the community] as much as possible, in terms of basic electricity services, for as little cost as possible; to make the project financially sustainable as well as upscalable, and also allow it to be replicated. The tech and business model need to suit that specific community, that specific situation, based on their income, household profile, the traditional fuels that they are using, all of that needs to go in. That essentially identifies the tech you'd use."

While matching technology and a business model to a specific context is part of being adaptable, being 'technology neutral' has also allowed for greater levels of efficiency for the iShack Project, as it has the freedom to use some of the latest technology. As PM (06/12/2016) emphasized, "a lot has happened in the solar home system space in the last 3 years. In terms of sophistication of charge controllers, which is basically battery protection, they are lasting a lot longer. And so, there is just a lot better stuff out there now. We did scour South Africa for good products, SSS are still one of the best local suppliers here, but we went to East Africa as a fact-finding mission in Kenya and Tanzania and visited all the major solar home system companies there. The latest tech is out there because of the very high levels of

unelectrified villages, and we came across a few systems that we wanted to try out."

The iShack team looked at about 6 different solar home system companies and did a comprehensive assessment on each of them during this fact-finding mission. The BBOXX solar home system was identified as being the best suited for the context and needs of Enkanini. BBOXX was not necessarily the best, but it did suit the model that the Project is working on - transitioning towards free basic solar. This technological transition and the innovation associated with the BBOXX units are central to the set up and direction of the low carbon energy transitions taking place in Enkanini.

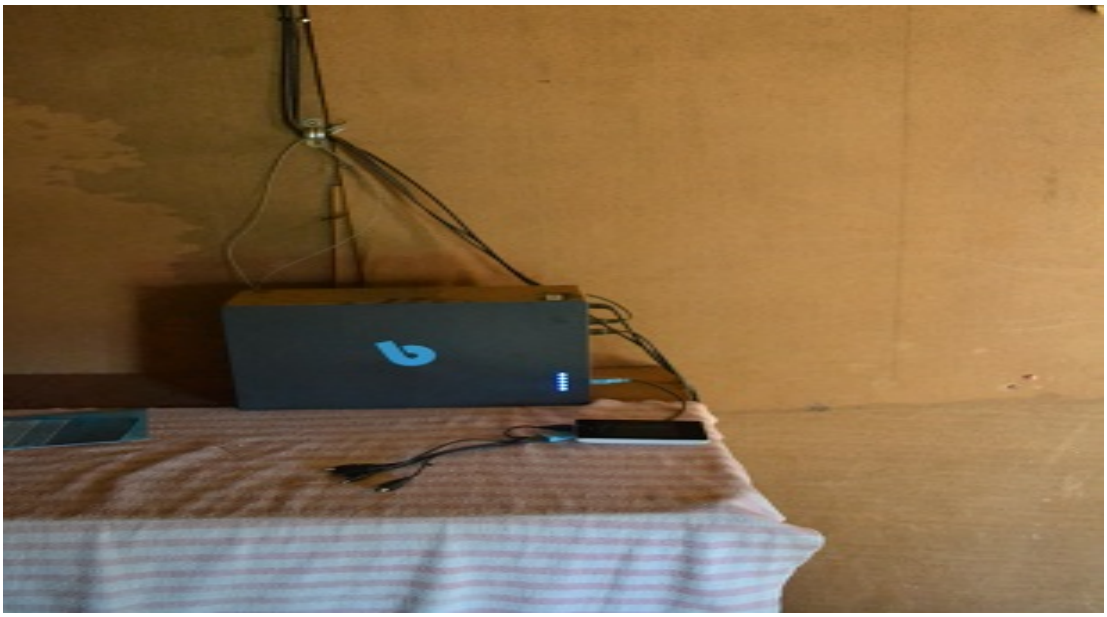

Figure 18 – A newly installed BBOXX unit. Notice the anti-tamperproof covering which keeps the components of the unit protected (Glasser, 2016).

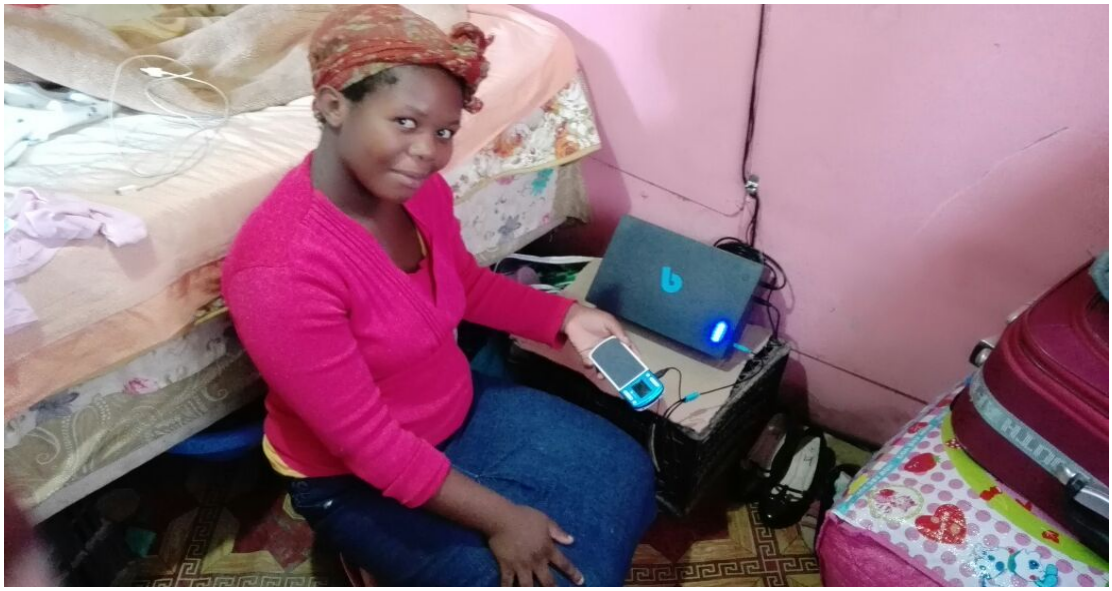

Figure 19 – A client charging her cell phone from her newly installed BBOXX unit (Glasser, 2016).

There are various innovative aspects to this transition that provide greater efficiency, support and data for the iShack Project. The first of such innovations are the improvements and availability of real-time data, which provides a broader range of information and greater clarity that can help the Project with troubleshooting issues and maintenance queries. The SSS systems work with a sim card inside of them, allowing iShack to turn the systems 'on' or 'off' with an sms. On the other hand, BBOXX has a "smart solar dashboard" which allows the Project to view real time load profile information, such as: battery voltage, battery temperature, charge from the panel, current going out, number of amp hours left in the battery, etc. It essentially provides a minute-by-minute load profile view of each client, which means the Project no long has to rely on broad, overall statistics and percentages but household specific individual sets of data.

This obviously has implications in terms of designing the right kind of system and monitoring how the system is used, but when it comes to the clients having issues, such as maintenance queries, the iShack Agents are able to

sort a lot of technical issues and troubleshooting queries over the phone. The Agents are essentially able to look at that client specifically and see how often and for how long they are using the system, and what kind of charge the battery is receiving, and from that deduce the possible reasons why the system is experiencing difficulties.

Furthermore, as it has already been show, settlements such as Enkanini are informal and full of intricacies, so this kind of data is also incredibly valuable as there is not a lot of data that looks at urban informal settlement load profiles. Policies on energy provision have not engaged with the peculiarity of energy use patterns in informal settlements such as Enkanini. As such, the data generated through these load profiles can assist with the development of more targeted interventions in informal settlements.

Secondly, there have been significant improvements to the charge controller, which has subsequently increased the lifespan of the system. This has led to a reduction in the number of maintenance calls, which translates into clients saving money, as they do not have to pay for call-out fees. Similarly, iShack is saving money from not having to replace systems, or components of systems, as regularly.

The third component is that the BBOXX units are better equipped to resist tampering. For example, if someone opens the BBOXX unit, the Operations and Data Manger will receive a notification and the system automatically disables. If someone overuses the system or tries to plug in an appliance that is not compatible with the system, it sends a notification and disables the system. So, there are added layers to better protecting the systems. It was possible to bypass the DB box charge controller with the SSS systems and

connect the solar panel straight to the battery, which can destroy the battery by overloading it or allowing the client to overuse it. The costs of repairs or replacements ultimately jeopardizes the financial sustainability of iShack's business model.

Due to the regularity of tampering, managing the SSS systems became far more difficult, especially when clients defaulted. The clients would not pay for the service, which would force iShack to turn the system off until payment was received. But these clients would then tamper with the system and continue using it free of charge, while draining the battery in the process. This meant that the Project would not be receiving income from these clients; they would be damaging the battery and then potentially damaging other components of the system, which would lead to replacements, or repairs, which would in turn incur and the costs.

Fourthly, fail communications (when the solar home systems cannot be contacted/controlled by the iShack Hub, when they attempt to turn them on or off) has been a significant restriction with the SSS systems, but this has not been the case with BBOXX. This is due to the fact that the BBOXX systems use mobile data within the switching mechanism, which reduces the frequency of fail communications occurring. Whereas the SSS units were using a system that relied on sms's, which may not have reached or have been registered by the system.

Finally, the appliances themselves are more efficient with the distribution and use of power. The BBOXX TV's are 1 amp, and the BBOXX batteries have improved technology being gel, which make them significantly lighter and therefore a lot easier to carry, replace and transport. As a result of being a

gel battery, the expected lifespan increases from 2 years to that of 4 years. Combining this improved battery technology with a more sophisticated charge controller makes it harder for the client to overuse the battery.

The previous SSS systems work on a 'cut off' and 'cut on' voltage – if the battery drops to a certain voltage it cuts off and then it waits for it to recharge to a sufficient voltage before it turns back on again, allowing 6-8 hours of use out of the system. The cut on cut off voltage settings were not very robust and were not doing what they were supposed to be doing, which immediately affects the battery use and lifespan, which is central to the Projects business model. PM (06/12/2016) highlighted how the iShack Project business model relies on the battery's lasting at least 3 years, and if they start failing before 2 years the model is in jeopardy. So, using a battery that has a life expectancy of 4 years strengthens both the system and business model.

However, as stated earlier, the decision to go with the new BBOXX units did not solely rest on the technology it provided but because it could be aligned to the business model of the Project, with the FBE subsidy. It enables the Project to offer smaller, entry-level systems that provide the basics - 3 lights, cell phone charging, and no TV to start with initially. This system would be covered by the FBE subsidy each month.

As PM (06/12/2016) explained, "it would basically be an all-inclusive offer to clients because the contract is a monthly fee and not all people could afford that R130 per month for contract, or even the R80 a month for having lights only. The idea was to implement a smaller system as an entry-level service that people can get with no monthly fee. That's why the battery is a lot smaller [with regards to its amps]. The cost of using this system, because the

FBE subsidy helps cover it, is now free. The way the business model has now evolved is that if the iShack Project have at least 1000 clients connected, the baseline operating costs are covered by the FBE subsidy, and the clients are able to pay in extra for what they need over and above that."

This underlines the importance of an intermediary being able to diversify its supply chain and use different kinds of technology. New technologies can help improve a system and are an essential aspect of being able to adapt to new restraints or pressures that may arise over time. More so, the technology needs to be matched to the context and needs of those living in the informal settlement. That was the primary reason for introducing the BBOXX units, as they matched well with the business structure of the iShack Project. They provide the basic electrical needs required of the FBE grant, with greater efficiency. This fulfils the first key point of an intermediary's success: to have the aims and objectives of the intermediary met, as well as suiting its budget (Hodson and Marvin, 2010). This is essentially a co-benefit for both the clients and the iShack Project, as both benefit from using a more efficient system.

5.2.1 The role of community engagement

Community engagement has greatly influenced the efficiency and adaptability of the iShack Project. As it will be shown, it has contributed to the evolution of iShack's Client Management Policy (2017) and has directly influenced the way in which client's sign-up for their solar home systems, how these systems are financed by the clients, and has contributed to greater levels of communication by developing group representatives. However, community engagement is also foundational to community buy-in, which is essential to the success of an intermediary and niche innovation.

As PM (06/12/2016) explained iShack's experience with Enkanini, "you do need community buy-in at the beginning with these projects, as the settlements sort of have these 'gatekeepers' and very informal leadership structures. The community does need to buy into it for it to be successful. But as far as ownership from the community goes, I don't know how much we can actually control, we just need to do our homework at the beginning, to make sure everyone is aware of what's happening in the settlement, and that largely comes about through community engagement. So, ownership will really come from the iShack Agents who are local residents, which is part of the social enterprise model – they have to be from the community."

iShack's Client Management Policy (2017) is the primary tool that outlines the way in which the intermediary engages with the community, the various procedures and protocols to be used for a range of issues. These issues can range from the contracting phase for 'Free Basic' clients, who are shown the "Free Basic Contracting Video" (which helps explain the contracting process in greater detail), to the financial aspect of clients setting up an 'iSolar Account' (which is used to help clients budget and save for battery replacement), to the formation of 'Client Groups' and their associated benefits – see Figure 20 below.

Yet, the policy document always ensures that the overarching aim of the Project, to "provide a quality, affordable electricity service to a large client base"[7] (Client Management Policy, 2017: 1). It raises economic and social concerns central to the issue of justice, and outlines a variety of mechanisms that can be used to overcome them.

[7] Permission to reproduce this internal document has been granted by the iShack Project. It is currently under review, only to be used within the capacity of this dissertation.

One of these mechanisms is to always move "defaulting clients" (clients not meeting their monthly payments) to the "Free Basic" package, to alleviate the financial requirements of the contract, thus ensuring the client still has access to basic lighting (Client Management Policy, 2017: 3). Another mechanism is that of the 'group-financing scheme', which allows residents to approach iShack as a group of clients, lowering the registration fee and also encourages monthly savings for future maintenance calls and replacements (Client Management Policy, 2017: 5-6). The benefits of the 'group-financing scheme', in comparison to being an individual client, are highlighted in the box below (Client Management Policy, 2017: 6).

	Individual	Group
System deposit	R400 per client	R300 per client
Installation fee	R100 per client	FREE
Installation	Single clients may have to wait	Groups get installed quicker
Electricity Fee	FREE	FREE
iSolar Account	You save yourself	You save yourself and with Group iSolar Account
Maintenance	More expensive	Cheaper
Cost of TV	Pay upfront	Possible rent to own, with switching pay-plan
Panel/Battery upgrade	Pay upfront	Possible rent to own, with switching pay-plan

Figure 20 – Comparison between being an individual or group based clients, and the associated benefits.

As defined in iShack's Client Management Policy (2017: 5), a group is 4 to 10 people, of whom one is elected as the Group Representative and another becomes Vice Group Representative. The Group Representative becomes the iShack Project's contact person. A prerequisite of joining a group is that

no member may be more than 5 shacks distance from another member.

Clients can choose their own groups, but the project will assist new joining clients in finding possible groups to join. Some of the benefits of being in a group are highlighted above: clients receive a discounted system deposit, no installation fee and have the possibility of applying for an 'Upgrade Payplan'. The Project also benefits by having a single contact person for a group of people and installations are easier when installing systems for clients that live nearby to one another.

PM (06/12/2016) explains in greater detail how iShack tries to "enable group formation to help that social process so neighbours can get together and brainstorm issues and decide what they would like to do with them, as a street committee. Then they can come back to us with their suggestions, through their representative. Each group would have a representative, and this is what I am hoping will kind of kick off that social process. It is going to continue evolving and we are going to need a platform for dialogue with the clients and we need to be able to reach as many as possible. Groups are the size of 10 and each group would have 1 group representative and just through that 1 group representative we can get this kind of feedback from the client group meetings that they hold themselves." In essence, the Client Management Policy (2017) encourages public participation and community engagement through the formation of these groups.

The policy also emphasizes the importance of handling each situation in a case-by-case manner (Client Management Policy, 2017: 2-3). This was incredibly insightful as I became more aware of the intricacies and informalities of Enkanini and its residents. For example, there is a huge gap between what one resident may be earning compared to another, thus

influencing the package types the iShack have to offer. Furthermore, it is often the case that residents are moving between informal settlements, or may just simply leave Enkanini all of a sudden for personal reasons or in search of employment. This complicates the process of contracting and repossessing (important when trying to ensure systems are not stolen when clients leave the settlement) systems, as well as ensuring a source of payment, especially when attempting to confirm whether a client may be out of Enkanini for the long-term or short-term.

However, the primary point is that the policy document of the iShack Project has evolved overtime, as a result of community engagement and public participation. Many of these changes to the policy document have already been highlighted, such as moving defaulting clients to the "Free Basic" package, handling each situation in a case-by-case manner due to intricacies and informalities of working in an informal settlement, as well as promoting group formation so that issues can be brainstormed issues. The policy document has also gone a long way in encouraging engagement and participation through group formation. These have resulted in positive outcomes, such as alleviating financial stress for defaulting clients, creating a system that is adaptable to a constantly changing environment, and creating street committees that provide a formal representation for clients.

Through a process of public participation and community engagement with the residents of Enkanini, understanding their needs and restraints, the changes to the policy document highlighted above represents an evolution within the iShack Project itself. The services and prices offered by the iShack Project have changed through the formatting of the 'group-financing scheme', to ensure client satisfaction, greater efficiency, and a business

model suitable to the context of an informal settlement and one which is also financially sustainable.

The importance of community engagement was also a highlighted by iShack Agents. As IA 1 (07/12/2016) explained, Enkanini was initially confused by the iShack Project due to the political leaders that lived in the settlement. "They promised this and that but at the end of the day they failed to do it. So, the people now, when they see iShack at the first stage they thought: "Hey, this solar system are going to stop us from getting electricity." But because of now, they see all of our community leaders and political leaders, they are not fulfilling what they promise, they come to iShack and said, "rather than to sit and wait for electricity we can make use of this service that you are providing as iShack Project." They started to come back to us and apply for solar systems."

With continued reflection and innovation, it is possible for the iShack Project to expand its operations. From a technical point of view, PM (06/12/2016) stated that "You just need to be clear on the contracts and how its strengthening the community because if they feel in any way that this is just a private company coming in trying to make money off of their situation, then it'll all be over before it even started. So, community buy in is really important." The role of public participation cannot go understated; it is not only essentially for initial take-off but expanding as well.

But the reason behind the initial uptake success of these solar home systems has been the engagement with the community. By providing a platform for group representatives to ask questions and voice their opinions, as well as prioritizing the contracting phase to provide training sessions and

educational videos after sign-ups, the iShack Project ensures that the systems are explained properly and the role of iShack and its relationship with the clients are clearly defined. This has formed "knowledge networks" which have assisted the processes of innovation within the iShack Project itself (Swilling, et al., 2013: 10) As PM (06/12/2016) makes clear, the strength and success of the iShack Project is not found by forcing a closed system onto its clientele base, but in allowing local knowledge to help evolve the system and make it more efficient for everyone.

5.2.2 The contracting process and its impacts

It is clear that community engagement and public participation are beneficial for both the client and the iShack Project. This view largely informed the emphasis that the iShack Project then placed on its contracting process.

As PM (06/12/2016) explained it, "the contracting process is your best opportunity to train the clients on how to get the most out of their system. We run them literally through a training process of 30-45minutes just to contract one client. We go through the panel, how it works, how to maintain, how to use it, how to clean it, how often to clean it, even to double check connections, make sure it's not in the shade, make sure nothing is covering it. We give them basic operation instructions on how to use the DB box and read the LCD readings, explain to them how the battery voltage works. We also explain to them the charge and that if the charge falls below a certain level then you need to stop watching TV until the battery voltage goes back up to a certain charge again. It also has a load reading, so anything over 2amps is too much and they'll eventually drain the system. So, we actually give them a little run down on amps, power and watts, the basics of an electrical system essentially, and how to operate it."

These findings relate directly to Bos and Brown's (2012) argument that the social learning process results in foundational changes in norms, values, goals, operational procedures and actors. Through this educational contracting process, clients are not only interacting with a new system that they have never had in their homes before, but are learning how to use this system in a way they have never been able to do before.

Another important reason for ensuring the contracting phase takes place, besides explaining the basic contract terms and the dangers of tampering, is to make sure that the client clearly understands the relationship between the themselves and the Project, what the iShack Project guarantees and the client's responsibilities. An important aspect of this is to ensure that the client knows that they do not own the system but that it belongs to the Project, hence the requirement of Contract clients to pay for the services rendered to them. The "Free Basic Contracting Video" forms part of this induction and is shown to clients at the Hub; usually to help cover all the questions these clients might have.

Ultimately, the contracting process between the iShack Project and a prospective client is a crucial interacting phase. It provides a platform for social learning to take place through participation. As PM (06/12/2016) explained, when the iShack Project starts the contracting process with an individual, it is regarded as the Projects opportunity to train that client, on the use, operation and even troubleshooting of the system itself.

Part of this social learning process is engaging with the community, and getting them to participate in this induction process. This is an important component of increasing an intermediary's capacity to act, as Hodson and Marvin (2010) argue the importance of effectively cultivating these local

networks to build trust and encourage local participation/buy-in. This also helps integrate local knowledge into long-term systemic programmes.

5.3 The relationship between policy and justice

The European Commission (2016) argues that policy is a mechanism that should be used to create an enabling environment, one that would help social enterprises scale their impact in providing technological innovations and services needed in communities. The FBE grant is central to iShack's ability to introduce low carbon energy transitions into Enkanini. The grant's impact on iShack, and iShack's efforts to improve the ability of the poor to access and afford electricity through technological innovations, such as "Flash" and the "Flash wallet", will be discussed. This is then linked to the FBE policy, and a clear connection between policy and technological innovation can be noticed, as well as policy and justice, within the realm of energy poverty.

The FBE policy was enacted in 2003 to meet the basic energy needs of poor households, while FBAE is intended to provide alternative energy where electricity is not available – such as liquid petroleum gas, bio-gel, and wood pellets - for different applications, such as cooking (DME, 2003; DME; 2007). It was calculated that the average poor household does not use more than 50kWh of electricity per month, and therefore an allocation of 50kWh of free electricity per month was set (DME, 2003).

The FBE and FBAE grants are regarded as the key ingredients in creating a space for incubators and intermediaries to form. As PM (06/12/2016) outlines, they are the entry point at which an intermediary like iShack can start a dialogue with local government; by offering itself as "a project to

provide services to an unelectrified community, in your municipal area that you haven't been able to service yet. So how about we provide the solar utility infrastructure and you pay us the FBE subsidy for every system we install in that community?"

This is a direct example of what Jaglin (2008) describes as a social enterprise's attempt to work with the state in bringing about environmental justice in rural communities through efficient service delivery. While iShack can provide this service delivery, where previously, the government has not been able to, it needs the support of local policy. But this also requires a partnership of sorts with local government. This essentially allows social enterprises and government to work together and define the quality and nature of services and developmental objectives (Jaglin, 2008).

"And so, for it to be financially sustainable, just to enable it, the FBE sort of allows that, just as long as it's a thousand shacks. If we're getting the FBE for those thousand shacks, baseline-operating costs are covered. And that's our main argument/pitch to the municipality. As well as explaining to them how much money they have actually saved by not installing that infrastructure, not having the pressure of all the service delivery protests that come along with that, not having to deal with the overflowing settlement that's having shack fires all the time because they rely on 90% paraffin for cooking, eating and lighting" PM (06/12/2016).

The FBE grant is not only a necessity for iShack to operate in Enkanini, but would also be a prerequisite if it wished to replicate and expand into other informal settlements. This process would require that an intermediary, like iShack, would need to provide a project implementation plan according to the information received from the relevant needs analysis and site

assessment of an informal settlement. From there, the suitable technology would need to be procured and a financial plan could then be forecast. As an incubator, iShack would seek to establish an onsite hub within that community and then train new iShack Agents from that community. As an intermediary iShack would essentially act as a middleman, by dealing with the hub operator of a community and the suppliers of solar home systems, between the hub operator and the capital grant (e.g. FBE or FBAE), and the hub operator and the local municipality for that region.

However, what is essential for this to take place, as PM (06/12/2016) outlines, "we'd need to be that intermediary accessing the FBE and dealing with all of those rules and regulations. Such as quarterly reports or whatever may be required by the capital funder, doing all the reporting and invoicing and maintaining a database for the FBE, so the municipality would pay that money every month, which would then be paid to the iShack Project and handed over to the relevant iShack Hub."

Naturally, the concern then is how changing local policy might impact, or already has impacted, the iShack Project. As PM (06/12/2016) highlights, it was incredibly important to work alongside the Stellenbosch Local Municipality to, initially, "figure out what the electrification plans were for Enkanini - which there were none. From this, inherently the interest of the Municipality shifted to the possibilities of alternative energy, to provide basic electricity services to the settlement. However, they simply did not have the time, resources, skill or budget to supply the infrastructure."

As PM (06/12/2016) described it, the Stellenbosch Municipality then decided to create a tender, to allow for a solar utility to provide 2000 households in Enkanini with solar power and receive the FBE grant for each of those

residents. While the government was initially unable to fully electrify the settlement, the iShack Project put forward its proposal of introducing solar home systems, which was granted the FBE subsidy. This was a huge break through; it was the first time the FBE had ever been used for a solar project/alternative energy project. As the solar utility provider, iShack provided the same services as what the FBE 50kWh is supposed to supply, which is lights, radio, cell phone charging, and basic media.

PM (06/12/2016) also stressed how this was "also the first time that this had happened in an urban settlement; it has happened quite a lot in rural areas, so it really was a pioneering project in that way. There weren't huge policy changes; they just kind of adjusted already existing policy to now suit a solar utility providing this infrastructure. Which they were very excited about because there weren't any plans to provide electricity infrastructure and they are actually saving a lot more by just giving us that FBE subsidy."

This establishes a clear link between policy and technological innovation. By adjusting policy, the Stellenbosch Local Municipality created an enabling environment for a solar utility (iShack) to introduce a low carbon energy transition (solar home systems) into an informal settlement (European Commission, 2016). Enkanini, a community that previously lacked adequate service delivery, is now receiving the services it requires. The iShack Project is able to work with the state and the community in bringing about environmental justice, through efficient service delivery (Jaglin, 2008). This also clearly establishes a link between policy and justice.

5.3.1 Access and affordability for the poor

How has this come to impact the budget of the Enkanini residents, and their ability to access and afford electricity? iShack has developed innovations, such as "Flash" and the "Flash wallet", as well as engaged with the community and promoted public participation, which have all come to influence the manner in which iShack clients manage and spend their money.

There are two vendors whom work with the iShack Project. One is called Simunye and the other is Jo Marlin – Figure 21 illustrates their location in relation to Enkanini and Kayamandi. Simunye is located at the main entrance to Enkanini and Jo Marlin is located at the main entrance to Kayamandi, which means that it does not matter from which side the residents make their way into Enkanini, there is a vendor on either side. These vendors allow clients to pay for the services rendered to them by the iShack Project, and because they are situated at either one of the main entrances into Enkanini, access to these vendors is greatly improved. While Simunye and Jo Marlin are the two place based vendors, the iShack Project has been in the process of introducing "Flash", a 24/7 mobile vendor.

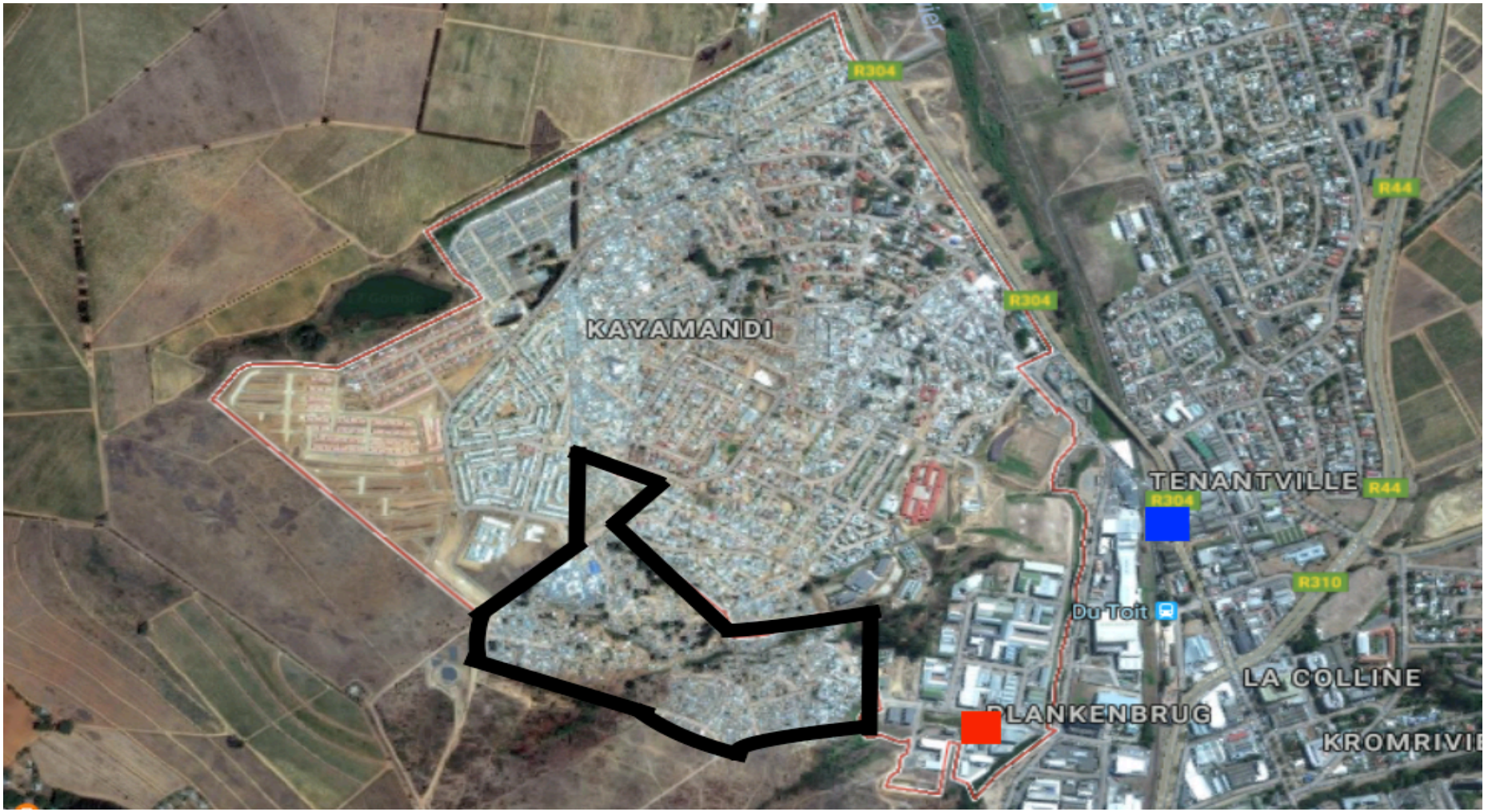

Figure 21 – A map of Kayamandi (outlined in red) and the informal settlement of Enkanini (outlined in black). Simunye is located as the red square and Jo Marlin is located as the blue square (Google Maps, 2017).

The iShack Agents raised a concern with the Managers in a meeting, stating that many of the clients only get back to Enkanini late in the evening from work, by which time Simunye and Jo Marlin are already closed. However, with the introduction of "Flash", clients are able to pay at all hours of the day, regardless of where they are, as long as they have airtime. Nevertheless, only a small percentage of iShack's clientele are actually using Flash. PM (06/12/2016) highlights that "they just use Simunye. Because they've always used Simunye and we only introduced Flash about 3 months ago."

This is illustrative of Bos and Brown's (2012) argument about social learning. It is a process that results in foundational changes in things such as norms and operational procedures, but this takes place over time, as familiarity with a process increases. This is the very same reason why iShack clients still use Simunye, "because they've always used Simunye" (PM, 06/12/2016). But similar to the way in which uptake with the solar home systems initially took place, it will eventually lead to a foundational change in the way of operational procedures, as residents of the community see the benefits of the service ("Flash").

As a result, the iShack Project is "trying to push it [Flash] for the BBOXX installations, which will have to use the service, and on Free Basic as well. They [the client] can use Flash and keep a bit of money in their "Flash wallet" to then pay us for maintenance callouts and whatever else they may need. So, they would have a bit of money saved in their "Flash wallet" and can just pay us on the spot" (PM, 06/12/2016). This essentially extends the innovations of this urban experiment past the mechanics of technology and into financial practices.

Furthermore, this is a manifestation of the FBE policy, which states that the benefits of the initial 50kWh per month allocated to poor households can be increased through "the efficient utilization of energy and savings interventions" (DME, 2003; 6). In line with PM's (06/12/2016) statement, the "Flash wallet" allows a client to save a bit of their money and use it to pay for maintenance calls or replacements.

By providing Flash as an extension of iShack's services, the justice issue of access is already addressed by allowing transactions to take place anywhere. While the introduction of a "Flash wallet" starts to influence the 'foundational changes' highlighted earlier, as saving financially for the future becomes an aspect of being an iShack client, addressing the issue of affordability. Encouraging clients to save for future transactions, which are inevitable considering battery replacement, the financial sustainability of the iShack Project is being considered, as well as the well-being of clients in ensuring the overarching aim of iShack to "provide a quality, affordable electricity…to a large client base… who collectively contribute sufficient revenues to the project to ensure that the project remains financially viable" (Client Management Policy, 2017: 1).

However, how did the iShack Project identify what the residents of Enkanini would be able to afford? PM (06/12/2016) explains that it was first important to identify "what people are using in terms of fuels and how much they are spending per month. The lights only contract, that's what people started with originally, they didn't get a TV, it was R80 a month. And that was a result of specifying the system and looking at the cost to provide a better quality of lighting with the solar home system, for less than what the residents were spending on paraffin for lighting. People, on average, spent between R100-R150 a month on paraffin and dry cell batteries for lighting. So, here's a much

better service that gives you access to better quality lighting for R80 instead of R150. From the outset, that issue of reducing the barrier of access and affordability was taking place, by offering a better lighting service than what they were already using. And then it evolved by people wanting extras and add-ons like TVs, and then they got to choose to pay more for that [this resulted in contract clients, who pay R130 a month]. But it had started off with a baseline of offering solar lighting for less than what people were paying to use paraffin. Now, with Free Basic, now that we have the FBE subsidy, we are offering this lighting service for free. People do not have to pay a monthly fee at all, so they should be saving a R150 a month from not using paraffin and dry cell batteries. So essentially, Free Basic Solar lowers the barrier of affordability completely because there is no monthly fee, and it's a much better service than what they were previously going for."

As PM (06/12/2016) stressed, "We [the iShack Project] are not a service provider that says, "this is what we have, this is how much it is, take it or leave it" but have much more of an investigative approach when it comes to identifying, consulting, specifying and sizing the right kind of technology and system for the settlement. One of the main being, how bad is the level of energy poverty? What types of applications do people need and want? Do we need to add a cooking technology to it? Do we need to add refrigeration to it? Is the settlement going to receive electricity in 2 years or only 10 years? All of these things need to be taken into account." But none of these can be answered without engaging with members of a community, getting them to participate in an urban experiment, and learning from them – as to what they value to be significant forms of knowledge, what are their financial restraints, their desires, etc.

Once again, it is clear how influential community engagement and public participation have been. By the iShack Agents raising their concerns regarding time constraints and the ability of clients to pay iShack for their services, "Flash" was introduced, minimizing the barrier of access. Furthermore, by engaging with community members, the iShack team were able to critically examine fuel use patterns, and investigate the necessity and/or alternatives for a low carbon energy transition to be introduced to Enkanini (Lawhon and Murphy, 2011). By identifying the arguments, values and interests of the stakeholders, the issue of affordability was addressed. First, by figuring out if residents would be able to pay for service rendered to them. And secondly, how much they would pay for this service, as well as how much they would save.

The contrast in opinions over service delivery, before and after iShack was introduced in Enkanini, highlights a social transition from a sense of abandonment to one of provision. This is evident in the desire and demand from other communities to have a project like the iShack replicated in their settlements. A clear need for an alternative delivery mechanism for energy security in informal settlements is evident, and solar home systems represent a viable means of overcoming energy poverty. This represents the potential of low carbon energy transitions to challenge notions of development in informal settlements

Innovative technology is an important part of this process, in being able to adapt to new restraints or pressures that may arise in these settlements. These technologies need to be matched to the context and needs of those living in the informal settlement, ultimately leading to co-benefits for both the clients and intermediary. Community engagement and public participation are important components of increasing an intermediary's

capacity to act, as well as an effective means of cultivating local networks that build trust and encourage local buy-in (Hodson and Marvin, 2010).

6. Discussion

As the evidence above suggests, energy poverty, coupled with a lack of efficient service delivery, has created an opportunity to introduce low carbon energy transitions into an informal settlement, Enkanini. The benefits of the solar home systems are evident, with a desire to have them implemented in other communities. However, introducing innovative technology and tailoring it to the specific needs of a community, encouraging community engagement and public participation, and appropriately applying policy, all play an important role in supporting and expanding these initiatives.

As a result, in order to illustrate the opportunity that has arisen to introduce low carbon energy transitions into informal settlements, the gap between policy and delivery is discussed, with a focus on the relationship between an intermediary, like iShack, and the state being a significant factor in ensuring efficient service delivery.

Following from this, the role of an intermediary in developing niche innovations is discussed, focusing on the importance of maintaining a diverse supply chain and how community engagement influences the shaping of transitions.

Finally, the FBE policy and its impact on the iShack Project and its influence on justice will be discussed, in illustrating the link between policy and justice. As the evidence suggests, adapting policy is a significant factor in supporting

the replication and upscaling of low carbon energy transitions. This will lead to a concluding section, discussing how my own positionality had come to influence my research.

6.1 The gap between policy and delivery

There is a clear contrast between the dissatisfaction shown by the residents of Enkanini with inefficient service delivery on the part of government, compared with the increasing demand and satisfaction with the benefits of the services provided by the iShack Project.

As an intermediary, the iShack Project has been able to position itself between Enkanini's context and the technological possibilities and innovations that have arisen since the introduction of solar home systems to the settlement – such as group financing schemes, 'Flash', the 'Flash wallet', group representatives, etc. (Hodson and Marvin, 2009). This has created various windows of opportunity from which the iShack Project has been able to "re-think" Enkanini's context through technological transitions (such as those mentioned above) (Hodson and Marvin, 2009).

Secondly, iShack has strengthened its relationship with the Stellenbosch Local Municipality, which created an enabling environment for iShack to introduce a low carbon energy transition into Enkanini (European Commission, 2016; Hodson and Marvin, 2009). The decision by the Stellenbosch Local Municipality in 2015 to award the FBE subsidy to the iShack Project provided the intermediary with an income stream that has since been included into its business model. What this signifies is the possibility of moulding or adapting policy in such a way that windows of opportunity are then opened for intermediaries/incubators similar to iShack.

Thirdly, as an intermediary, the iShack Project has taken on the role of mediator - between different stakeholders, funders, and interests (Hodson and Marvin, 2010). A community that previously lacked adequate service delivery is now receiving the services it requires, as the iShack Project is able to partner with the state and the community, in bringing about environmental justice through efficient service delivery (Jaglin, 2008).

As with the case of the iShack Project, it is clear to see how policy can be adjusted to stimulate intermediaries and incubators that foster niche innovations in informal settlements. Not only can policy direct financial support towards the initiation and development of such projects, but it can also be used to maintain future financial sustainability. For example, through the FBE grant, all of iShack's baseline-operating costs are covered.

More consideration should be given to projects like iShack, which experience success through their engagement with multiple stakeholders. They are already reducing the risks of poor management outcomes and poor policy implementation, so government does not have to (Lebel, et al., 2006). As a result, policy has the potential to play a bigger role in supporting efforts to expand and upscale these projects, especially if government can see progress is being made, and long-term success is feasible.

6.2 The role of intermediaries in developing niche innovations

Urban experimentation is incredibly influential in establishing pilot projects that introduce new niche innovations in different contexts (Patel, et al., n.d.). Evolving out of the research and engagement of students from the Sustainability Institute in Stellenbosch, with community members of Enkanini, the iShack Project can be considered an 'emergent transformation' - as it

originated from technological innovations emerging from a university (Smith et al., 2005).

Intermediaries such as the iShack Project play an important role in urban experimentation and the development and delivery of niche innovations. As it has already been shown, the lack of service delivery to Enkanini provided the initial window of opportunity in which low carbon energy transitions could be introduced to the settlement. This epitomises Jaglin's (2008) argument, that it is often the case that uncoordinated market strategies are to blame for leading poor communities into a 'lock in' with substandard service delivery.

However, having utilized the opportunity that inefficient service delivery had afforded the iShack Project, infrastructural limitations within the community and technical issues of the SSS systems reinforced the importance of being 'technology neutral'. This proved to be a significant advantage in being able to match the proper technology with Enkanini's context and iShack's business model. Essentially, diversifying its supply chain became an essential part of iShack's improved efficiency and adaptability.

This links directly to Narasimhan and Kim's (2002) emphasis on upholding a diverse supply chain and actively pursuing diversification, which can often take place by pursuing products from international markets. This is what ultimately led the iShack team to East Africa, to conduct a comprehensive assessment of different solar home systems in an attempt to identify which was the best suited for the residents of Enkanini. They looked at about 6 different solar home systems before finally selecting the BBOXX solar home system.

As it has been highlighted, ensuring a diverse supply chain is also crucial for long-term prospects of being able to upscale and expand operations nationally. The ability to be both specific in addressing a particular problem, yet adaptable to different situations, provides a platform from which social learning and change manifest – creating opportunities for new niche innovations to arise (Castán Broto and Bulkeley, 2013a). Consideration for site specific criteria and the social aspects of a particular community links precisely with Swilling, et al. (2013: 10) emphasis on the necessity of urban poor organizations being able to access "knowledge networks" that assist the processes of innovation. This process assists the development and innovation of projects such as iShack, by matching the specific needs and context of a community with the appropriate technology.

Matching the needs and context of the Enkanini residents with the appropriate technology resulted in the iShack Project introducing the BBOXX units to the settlement. These units were not necessarily the most sophisticated products available, but they did suit the business model that the Project is working on - transitioning towards free basic solar. The iShack Projects business model relies on the battery's lasting at least 3 years, and if they start failing before 2 years the model is in jeopardy. So, using a battery that has a life expectancy of 4 years strengthens both the system and business model. These units allow the Project to offer smaller, entry-level systems that provide the basics, and are also covered by the FBE subsidy each month.

Furthermore, Castán Broto and Bulkeley (2013a) argue how urban experimentation considers both technical and social components, making it highly influential within socio-technical regime shifts because it can lead to

advancements within technical innovation (designs and technology) as well as social innovations (such as policy and financial mechanisms).

This was found to be the case with the iShack Project. Technical innovations, such as "Flash" and the "Flash wallet", as well as processes of community engagement and public participation, had a direct influence on the manner in which iShack clients managed and spent their money. Since introducing Flash as a 24/7 mobile vendor, the iShack Project has made it possible for its clients to make transactions anywhere, at any time. While the introduction of the "Flash wallet" and group financing schemes have led to a change in mind-sets regarding future financial planning. This relates to Bos and Brown's (2012) argument that the social learning process results in foundational changes in norms, values, goals, operational procedures and actors.

6.2.1 The importance of community engagement

Community engagement and public participation enable a community to see for themselves that an intermediary is not simply trying to make money off of their situation, but is actively trying to improve their living conditions. The image of an intermediary and the way in which it is portrayed is the sixth requirement that Hodson and Marvin (2010) include in their list of what intermediaries need to ensure, so that transitions and new innovations can develop and take form. They highlight the way an intermediary position's itself within a community and to its residents, which can largely determine if trust is built between itself and the community and whether its programmes/projects are received well and become successful (Hodson and Marvin, 2010).

Through community engagement and public participation, both the iShack Project and residents of Enkanini are able to discuss and contest differences in knowledge claims (Bulkeley and Castán Broto, 2013). Furthermore, providing an alternative means of addressing energy poverty in Enkanini has also led to alternative ways of learning, which have resulted in changes for both the residents of Enkanini and the iShack Project. One such change for the Project has been the evolution of its Client Management Policy (2017), which has directly influenced the residents, and the way they sign-up for their solar home systems, how they finance these systems, and how they communicate and interact with iShack through group representatives.

This has formed "knowledge networks" which have assisted the processes of innovation within the iShack Project itself (Swilling, et al., 2013: 10) As it has already been highlighted, the strength and success of the iShack Project is not found in forcing a closed system onto its clientele base, but in allowing local knowledge to help evolve the system and make it more efficient for everyone.

Patel, et al. (n.d.) highlights, an influential facet of urban experimentation is the way in which it cultivates and expands social networks, through which social learning can take place. This creates a space for engagement and participation, through which a system (e.g. a solar home system) can evolve to work effectively for both the end-users and the intermediary (Swilling, et al., 2013). Essentially, community engagement helps in achieving both an intermediaries project outcomes, and subsequently, its efficiency and sustainability (Pretty, 1995; Prokopy, 2005).

Community engagement and public participation have also proved to be foundational processes in identifying the constraints of Enkanini, such as residents' ability to pay for services, what they would be willing to pay, the infrastructural constraints of the settlement, as well as institutional factors that would challenge or place pressures on replicating the iShack Project in another settlement. However, identifying the constraints of a settlement allows for means of brainstorming ways of overcoming it.

As highlighted in the literature review, Hodson and Marvin (2010) explain that it is the way in which these constraints or pressures are responded to that often results in new opportunities for the future arrangement of the social and technical organization of infrastructure systems within cities. Ultimately, this creates a window of opportunity to conceptualise low carbon energy transitions and develop differently, and challenge contemporary socio-technical regimes. Community engagement is essential to the success of any upgrade that is to take place within a settlement (Tomlinson, 2006).

6.3 The role of the FBE and its impact on justice

Bouzarovski and Petrova (2015: 32) argue that state-led policies need to help promote pathways to increase access to modern fuels, which will improve livelihoods, human development and promote equity (Bouzarovski and Petrova, 2015). While the ultimate goal of environmental justice is to make environmental protection more democratic, Bullard and Lewis (1996) emphasize how it also considers prominent ethical and political questions, specifically concerning issues of responsibility and delivery. Such as "who should pay for this, and who is to benefit from these technological innovations?"

The FBE is a means by which the South African government aims to address this; as the policy makes it clear that government recognizes that "poor households do not benefit from the same efficiency and environmental benefits afforded by electrification due to the severe poverty" (DME, 2003; 5). This lack in access and affordability to safe, reliable and clean electricity has a direct impact on the livelihoods of residents, their time, income, productivity and agency.

However, by granting the iShack Project the FBE subsidy, the Stellenbosch Local Municipality has created a precedent by which local policy has been adjusted to support a solar utility. The Project has thus been able to offer its lighting service for free. This has essentially lowered the barrier of affordability completely because there is no monthly fee, and it's a much better and safer service than candles and paraffin gas, which the residents of Enkanini were previously reliant on.

This is a direct example of what Jaglin (2008) describes as a partnership between the state and a social enterprise, in bringing about environmental justice in rural communities through efficient service delivery. While iShack can provide this service delivery, where previously, the government has not been able to, it needs the support of local policy. This essentially allows social enterprises and government to work together and define the quality and nature of services and developmental objectives (Jaglin, 2008).

By adjusting policy, the Stellenbosch Local Municipality created an enabling environment for a solar utility (iShack) to introduce a low carbon energy transition (solar home systems) into an informal settlement (European Commission, 2016). Enkanini, a community that previously lacked adequate

service delivery, is now receiving the services it requires. This clearly establishes a link between policy and justice.

However, constraints such as skills shortages, inadequate infrastructure and frustration around service delivery are not specific to Stellenbosch. Nor is Enkanini the only settlement in the country that is unregulated, inaccessible and restrictive when it comes to infrastructural development. And as it has already been shown, the desire to see a project like iShack extend its base of operations into other settlements is not merely a business strategy for those who started it, but a common request from residents in informal settlements.

Upscaling and expanding an urban experiment, such as the iShack Project, to a nationwide scale is dependent on whether or not local policy would support this. This brings to the forefront the call by the European Commission (2016), for policy to be used as a mechanism to create an enabling environment, one that would help social enterprises scale their impact. In the case of iShack, it is only through the FBE grant that the baseline-operating costs of the intermediary are covered, and it is only through the grant that it is able to offer the 'Free Basic' package.

But if the service is free, why does not every shack in Enkanini have a solar panel on its roof then? Bos and Brown's (2012) argument is a reminder of the nature of the social learning process. Foundational changes in practices, values, norms and procedures is a complex process, and the time that needs to pass before such foundational changes take place should not be underestimated. It has only been four years since the Project initiated its solar rollout in 2013.

It is clear that policy plays a foundational role in not only strengthening intermediaries, but also allowing for their replication and upscaling. The adaptation of current policy to promote an enabling environment for intermediaries is evidently a viable option, meaning the creation of new policy is not always needed. But the use and application of the FBE policy has also shown that policy has a direct impact on justice, especially through the way in which it influences the ability of the poor to access and afford electricity, through iShack.

Dissatisfaction with service delivery represents a window of opportunity for intermediaries, such as iShack, to work with local government in bringing about environmental justice in rural communities through efficient service delivery. Policy plays an important role in supporting these efforts and allowing them to expand and be upscaled. Community engagement and public participation are also foundational in identifying the constraints of a community, allowing for the best-suited technology to be introduced.

6.4 Positionality

During the fieldwork component of this dissertation, my positionality became increasingly evident. Trying to navigate the racial and cultural differences of being in Enkanini proved incredibly complex and challenging. I was reminded of the evident racial differences and tension every time I was called "Umlungu". There were two particular occasions during maintenance calls whereby my presence had caused some infighting within conversations. Similar to the way in which Visser (2000: 232) describes his experience in his research on post-Apartheid local government, it appeared that in many instances, "groups were particularly suspicious of the underlying reasons for my interest."

From what I could gather, there were individuals in the shack that did not mind me being there (the owners) while there were others (neighbours; or in the case of the shebeen, a client) who did. Normally, I was simply called "Umlungu" to highlight my 'otherness' in this space, but at times it did make my attempts to observe interactions within the community all the more difficult. I sensed that my presence in some cases had essentially influenced the day-to-day routines of the residents, who gave off the impression that I did not really belong in the settlement. However, being accompanied by an iShack Agent or one of the managers, and witnessing the positive interactions between us, seemed to establish a sense of trust between the community and myself; as the community had already formed a relationship with these members of the iShack staff.

There were instances whereby clients would be speaking in broken English to one another, but when I appeared they started talking in isiXhosa. I assume this was because they wanted to keep their conversations private. However, the iShack Agents normally mentioned what had been said, but this material was never used.

7. Conclusion

This dissertation argued that low carbon energy transitions, such as solar home systems, are a viable means for overcoming issues of energy poverty in informal settlements. The iShack Project in Enkanini was used as a case study, highlighting in many ways that the introduction of low carbon energy transitions into informal settlements aims to address the shortfalls of service delivery and improve both its efficiency and delivery, to the benefit of those living in informal settlements. Whilst the conceptual frameworks, focusing on the MLP and political ecology assisted in providing key insights for understanding low carbon energy transitions, these frameworks were found to be limited in their explanatory potential. The focus on urban experimentation and intermediaries was found to be more generative for understanding the nuances of these transitions in the case of iShack.

This essentially recognized the "social added value" of intermediaries such as iShack – by examining whether or not their services or products have an impact on the problem they aim to solve and if their operations can be upscaled to include more people (European Commission, 2016: 3). Furthermore, it addressed the first objective of this dissertation through analysing how low carbon energy transitions are initiated and implemented in informal settlements, for possible upscaling. In contrast to poor service delivery and a sense of abandonment, the social benefits associated with the iShack Project are far reaching, and have created a sense of worth for those living in the community of Enkanini.

The study also investigated the relationship between technological innovations and how the associated benefits of the BBOXX units contributed to positive changes in social norms – providing a sense of security, means of education, keeping children off of the street, and has direct positive implications on the lives and health of those living in the settlement due to reduced shack fires and electrocutions. A clear link was established between policy and technological innovation, within the realm of energy poverty. This addressed the second objective of this dissertation by focusing specifically on how windows of opportunity are utilized for the introduction of new innovations, as well as the improvement of services and technology.

Running a solar utility project off the national grid requires and relies on constant innovation and reflection, in incorporating more efficient technology and matching the right technology to the needs, desires and constraints of a community, which can change over time. This is evident in the advantage of being 'technology agonistic/neutral', maintaining a diverse supply chain and ultimately being able to match technology to a context. This creates new ways in which urban experimentation can lead to advancements in the design and technological components of technical innovation (Castán Broto and Bulkeley, 2013a).

The role of policy, specifically the FBE, in supporting the implementation of low carbon transitions in Enkanini was also discussed. This helped identify the opportunities policy can afford low carbon energy transitions in informal settlements, as well as the impact it has on the lives of residents there. This addressed the third objective by analysing the relationship between justice and technology, by unpacking the multiple dimensions of justice in energy poverty, and the ability of poor communities to access and afford electricity.

By providing "Flash" as an extension of iShack's services, the justice issue of access is addressed by allowing clients to pay for the services rendered to them at any place or time. While the introduction of a "Flash wallet" and group saving schemes have led 'foundational changes', as saving financially for the future becomes an aspect of being an iShack client, addressing the issue of affordability.

It has been shown that the success and strength of an intermediary, like the iShack Project, involves engaging with the residents of an informal settlement and encouraging public participation, as well as partnering with local government. iShack's relationship with local government played a crucial role in the innovative incorporation of the FBE grant, which has made all of this possible. Local government plays an important role in being able to adapt local policy in such a way that it creates an enabling environment, for an intermediary to be strengthened or encouraged to replicate.

As Bullard and Lewis's (1996) argue, government determines whether or not welfare-enhancing policy recommendations are adopted, and in exacting environmental justice across social groups. Beyond this, the expansion of solar utility projects like the iShack Project, nationwide, in and of itself would have huge implications for other projects to do similar things in alternative energy. It would show that low carbon energy transitions, such as solar panels, are a viable option for overcoming issues of energy poverty in informal settlements, and that the technological innovations and associated benefits of these transitions help in addressing issues of accessing and affording electricity for the poor, as well as contributing to positive social changes.

The role of urban experimentation cannot be understated in this process, as it holds massive potential in creating windows of opportunity to conceptualise low carbon energy transitions and development differently, which challenge contemporary socio-technical regimes. Having the ability to look at the needs, desires, and constraints of an informal settlement and the residents within it, and then tailor technology, policy and procedures to that context is the strategic success of iShack's adaptability as an urban experiment. And all of this was only possible through community engagement and public participation.

It is also clear that having a local base of operation in the community and engaging with members of that community is effective in gaining community support, establishing a stronger relationship with the community and creating a platform for the voices of that community to be heard. iShack's contracting process was found to be a primary means through which the Project could ensure community engagement took place, which played a role in evolving iShack to better manage and reduce the risk of poor management outcomes, as well as ensuring that the solar home systems are working efficiently for their clients (Lebel, et al., 2006). Empowering and including the poor into the process of their own upliftment is beneficial for everyone involved. The iShack's involvement with the residents of Enkanini, listening to their voices, providing services they need and desire at an affordable rate, as well as employing some as iShack Agents goes a long way in making sure no-one has to feel like a "forgotten person" anymore.

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Annex 1 – Interviewee's

To ensure that the identity of those I interviewed is kept anonymous, each person has received a code indicated below, as to also allow the reader to keep track of who is being referred to.

There are three categories. The first are either of the iShack Managers, second are the iShack Agents and lastly, there are the clients.

Interviewee	Code
Project Manager	PM
Data Manager	DM
iShack Agent	IA 1
iShack Agent	IA 2
iShack Agent	IA 3
iShack Agent	IA 4
iShack client	IC 1
iShack client	IC 2
iShack client	IC 3
iShack client	IC 4

Annex 2 – Interview guide for the gap between policy and the delivery of energy solutions

This is an interview guide for the first research question - What is the gap between policy and the delivery of energy solutions to informal settlements? The 'Questions' column highlights the questions used to collect data for each 'Component' (research question) of this project, while the 'Outcome' column provides an indication of the desired result to be produced by each question.

Component	Questions	Outcome
Gap between policy and the delivery of energy solutions to informal settlements.	How changing local policy might impact or has impacted the iShack Project?	Identifying policy outcomes.
	How efficient is service delivery in Enkanini?	Identifying the gap between policy and delivery.
	What needs to happen to see intermediaries, such as iShack, being implemented on a national scale? - Could expand onto issues of funding, policy changes, etc.	Identifying windows of opportunity.

Annex 3 – Interview guide for the role of intermediaries and urban experimentation in the development and delivery of niche innovations

This is an interview guide for the second research question - What is the role of intermediaries and urban experimentation in the development and delivery of niche innovations to informal settlements? The 'Questions' column highlights the questions used to collect data for each 'Component' (research question) of this project, while the 'Outcome' column provides an indication of the desired result to be produced by each question.

Component	Questions	Outcome
Role of intermediaries and urban experimentation in the development and delivery of niche innovations. …	What sorts of fuel were people in Enkanini using before iShack?	Identifying the various approaches and practices of the residents to secure energy.
	Could everyone afford/access these fuel types?	Identification of restraints for residents.
	What are some of the differences of using iShack instead of previous fuel types?	Identifying the impacts of this urban experiment.
	What forms of social learning take place?	Identifying what forms of knowledge the residents find appropriate.
	What opportunities have allowed the iShack Project to become more efficient and innovative?	Identifying windows of opportunity.

Annex 4 – Interview guide for the relationship between the FBE/FBAE and the creation of just cities

This is an interview guide for the third research question - What is the relationship between FBE/FBAE and the creation of just cities? The 'Questions' column highlights the questions used to collect data for each 'Component' (research question) of this project, while the 'Outcome' column provides an indication of the desired result to be produced by each question.

Component	Questions	Outcome
Relationship between the FBE/FBAE and the creation of just cities.	How has the FBE/FBAE influenced urban experimentation?	Identifying the link between policy and technological innovation.
	How has the FBE/FBAE impacted the individual lives of the residents of Enkanini?	Identifying policy outcomes.
	Has the FBE/FBAE supported the iShack Project and its objectives?	Identifying the link between policy and intermediaries.

Annex 5 – Additional questions to consider

The aim of these questions is to gain data from the three identified stakeholders, in an attempt to answer the research questions and meet the objectives of this dissertation.

iShack Project Manager:

→ What are some changes you think the iShack Project needs to make?

→ Is it possible to create a 'replication strategy' for an innovation such as the iShack Project?

→ In what ways have these opportunities affected the clients?

→ What is the significance of the contracting phase of the project?

Enkanini residents:

→ In what ways has the iShack Project affected you?

- Could expand onto issues of jobs, health, security, money, etc., which would result in new questions and conversations.

→ What changes would you like to see from the iShack Project?

- The project manager mentioned some of these issues already, such as renting versus ownership.
- Could lead to concerns of access and affordability.

→ Do you think other communities could benefit from projects like iShack?

→ What changes would you like to see from the government?

→ What sorts of fuel were people in Enkanini using before iShack?

→ Could everyone afford/access these fuel types?

→ What are some of the differences of using iShack instead of previous fuel types?

iShack Agents:

→ How has the iShack Project affected your life?

- Could expand onto issues of employment, income, training, etc.

→ What are some changes you think the iShack Project needs to make?

→ What does the community think of the iShack Project?

→ What challenges do you face working for the iShack Project?

→ What are some of the requests or inquiries clients often make of the iShack Project?